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MACHINE FOR MAKING TAN-BARK FUEL.

THIS is a French machine, and has three large stamps, which are furnished with counterweights at their upper ends (one of these stamps is animated by a rotation movement), a horizontal shaft provided with cams which is destined for the lifting up of the stamps, and a horizontal revolving plate containing six circular openings which serve for moulds. Besides these, there is a charging funnel, which communicates with two of the openings in the revolving plate.

The rotation movement is given to the revolving plate by a bracket on one of the cams. This bracket supports one of the teeth of a rack wheel fastened to the vertical middle shaft of the revolving plate.

Always, whilst two moulds are filling, three are submitted to the action of the stamps, and the sixth is emptying its contents. At each turn of the horizontal shaft, the plate completes one-sixth of its turn. Whilst the stamps are lifted up during the movement, they fall down every time that the movement of the plate is arrested.

As soon as the motion stops, a piston lifts out the finished cake, and this latter is received by a special apparatus which is placed on one of the sides under the machine. The stamps which are lifted up during the emptying of the moulds, fall down again as soon as the cams withdraw their support, and compress the containings of the other moulds.

The vertical shaft of the revolving plate has on its upper end a spur-toothed wheel, which acts upon a pinion at the shaft of the last stamp, *i. e.*, upon a pinion of the shaft of that stamp, which precedes the piston for the lifting out of the cake. By this arrangement, the rotation movement of which we spoke is accomplished, and the work done, which had to be performed heretofore by the foot of the workingman. The tan which was compressed by the action of the first stamp is afterward turned and evened at the surface by the rotation movement of the last stamp, and in this manner absolutely regular tan-cakes of a perfect quality are obtained.

To avoid any possible deviation of the revolving plate its circumference is provided with six grooves in which, at each one-sixth turn of a plate, a little lever enters, which is acted upon by an automatic movement, dependent on the great tooth wheel of the cam shaft.

Masson's machine does not use more than one horse-power for its action, and can, when it is managed by three women and three children, manufacture 15,000 cakes within twelve hours. The price of the machine is $240.

The cakes are six inches in diameter, and half an inch thick. Their average weight is about one pound.

The tan cakes manufactured in this machine can at once be spread out, and dry very rapidly, if well-broken and well-mixed oak bark has been used and no water has been added, and they obtain a great hardness and durability. Mr. Clavé-Bertrand, a tanner in Conlommiers, France, has two of Masson's machines, and produces by each of them 1,800 tan cakes per day.

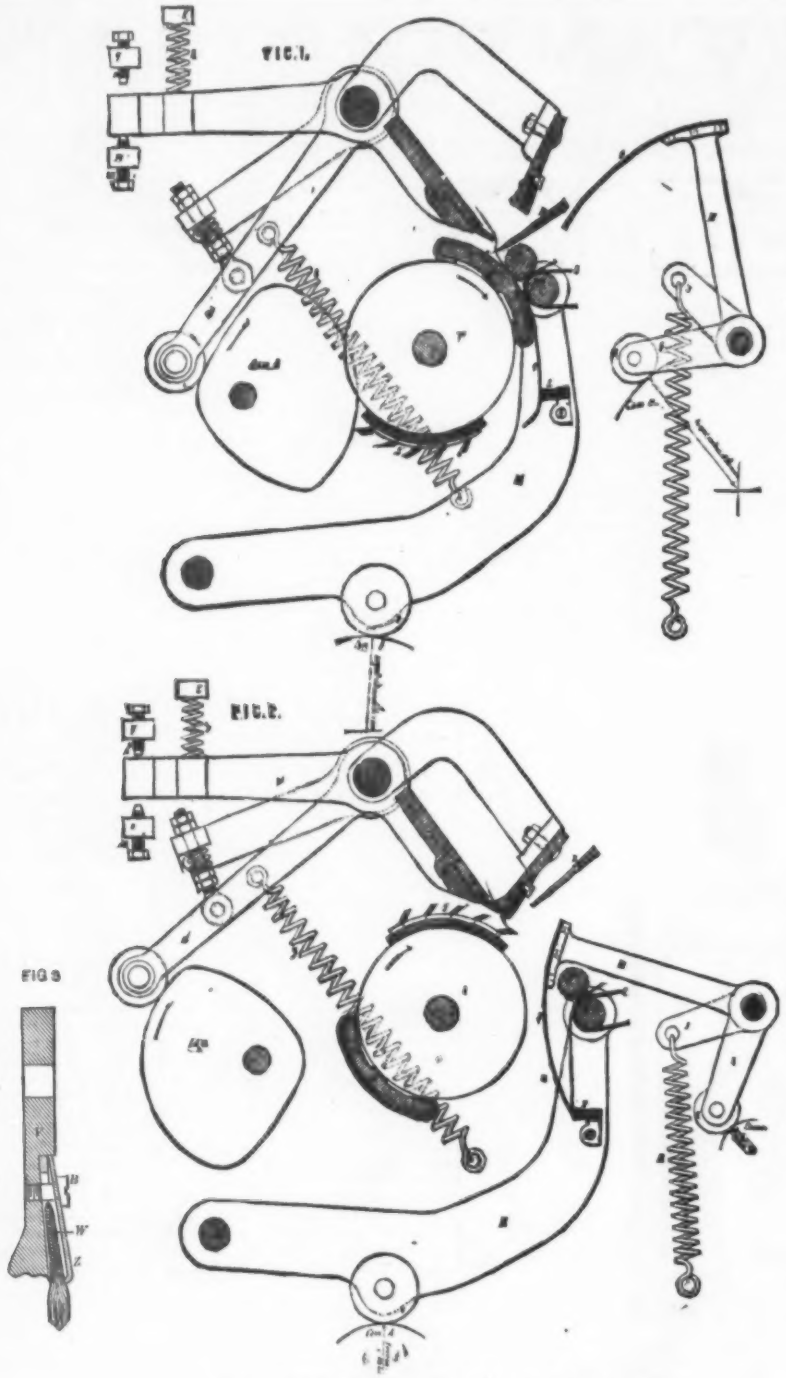
MACHINE FOR MAKING TAN BARK FUEL.

IMPROVED HEILMANN COMBING MACHINE.

M. ALBERT D. R. DUJARDIN, of Lille, has recently introduced several important improvements into the well-known combing machine known as Heilmann's, the essential principles of which will be found illustrated in the figures on the next page.

The first improvement consists in a device and combination of mechanism designed to draw the fibers which have been seized by the detaching rollers wholly out of the top comb, and to protect or keep these fibers clear of the teeth of the comb cylinder, which would be liable to break any fibers they might touch.

The arrangement employed is illustrated in Figs. 1 and 2, in which F is a shaft mounted in bearings, and E is one of two or more arms attached to it, and carrying a curved longitudinal blade or shield, D; G is an arm also fixed on shaft, F, and provided at its extremity with a friction roller, K, acted on by a cam, C, whereby the requisite movements are imparted to the blade, D. H is a spring attached at one end to a fixed point, I, and at the other to the end of an arm, J, fixed on the shaft, F, so as by its tension to keep the roller, K, against the cam, C; L is a brush fixed on the arms, M, in which the lower detaching roller is mounted. The arms, M, are operated by a cam, A, acting on the friction roller, N; O represents the combed filaments; P, P^1, are the detaching rollers; Q is the endless leather apron of the lower detaching roller; R is the top comb; S the comb segment; and T the comb cylinder; U is the segment on the comb cylinder against which the detaching rollers, P, P^1, act.



IMPROVED COMBING MACHINE.

The following is the action of the apparatus: During the first stage of the detaching, as shown in Fig. 1, the blade, D, is held up in a position of rest by the cam, C, so as to enable the detaching rollers, P, P^1, to draw the fibers through the comb, R, in the manner usual in the Heilmann and Schlumberger combing machines. When the detaching rollers, P, P^1, are lowered by their arms, M, to the position shown in Fig. 2, the blade, D, is, by the action of the spring, H, lowered in front of the rollers, and thereby completes the detaching of the fibers which were still engaged in the teeth of the comb, R. The blade, D, on arriving at its lowest position, presses the fibers against the brush, L, by which they are retained sufficiently to prevent them rising with the blade, D, on its return to the position of rest, as shown in Fig. 1. The cam, C, is of such form as to insure the upward and downward movements of the blade, D, at the proper moments. It will be seen from the position shown in Fig. 2 how the blade, D, serves to protect the combed fibers from the action of the cylindrical comb, S.

The second improvement is illustrated in Fig. 3, and consists in the application of a brush to the upper jaw of the nipper in such a way as to press the fringe or tuft of fibers protruding from the nipper on to the teeth of the comb cylinder, and thus cause the latter to penetrate completely through the fibers. V is the upper jaw of the nipper; W is the brush clamped to the jaw by the plate, Z. The brush, W, is intended to compel the teeth of the cylinder comb, upon which it tightly presses, to penetrate completely through the fringe of fibers protruding from the nipper, as shown in Fig. 2. Without this brush it is impossible to bring the nipper sufficiently close to the cylinder comb to insure the teeth penetrating completely through the fibers. The nipper brush is very narrow from front to back, so as to occupy a very limited space, and necessitates but a very slight alteration in the position of the top comb, otherwise it would lessen the production of the machine. The brush is made of soft bristles, which are held by their root ends in a longitudinal sheath, X, of U section, received in a rebate in the jaw. The points of the bristles project beyond the edge of the jaw, and are clamped thereto by a plate, Z, and binding screws, *a*. An adjustable metal bar or packing piece, Y, serves both for the plate, Z, to bear against and to regulate the distance that the brush projects beyond the jaw, and at the same time prevent the brush from being forced inward.

The third improvement is illustrated in Figs. 1 and 2, and consists in an arrangement of the nipper in which both jaws are movable on a common axis, so that when the nipper is opened the lower jaw can be adjusted to move to any desired position; and yet, when the nipper is closed, it cannot pass beyond a certain limit. *b* is the lower jaw, working upon a shaft, *c*, as a center, and V is the upper jaw, carried by a pair of arms which are made fast on the same shaft. An arm, *d*, loose on the shaft, *c*, is provided with a friction roller, *i*, and is acted on by a cam, B, in order to operate the upper jaw through a spring, *f*, and an arm, *e*, keyed on the shaft, *c*; *g* is a spring attached at one end to a point, *h*, and at the opposite end to the arm, *d*, in order to keep the friction roller, *i*, in contact with the cam, B. A spring, *k*, confined between a fixed stop, *l*, and an arm, *r*, which is in one piece with the lower jaw, presses the latter against the upper jaw when the upper jaw closes down upon it to nip the fibers; *m* is a screw stop passing through a fixed nut, *n*, for regulating the upward movement of the lower jaw; *p* is a similar screw stop, passing through another fixed nut, *q*, for limiting the downward motion of the lower jaw. The spring, *f*, is stronger than the spring, *k*, and its interposition between the arms, *d* and *e*, enables the upper jaw to yield when slivers of excessive thickness come between the jaws, so that the lower jaw having first yielded to the extra limit allowed by its screw stop, *p*, the upper jaw does not descend the whole distance to which it can be moved by the cam, B.—*Universal Engineer.*

THE DOBBY MACHINE OF AINSWORTH.

THE Dobby machine is the best adapted for the weaving of fantastic patterns; for example, those which contain from twelve to thirty blades. The mechanical principle of this machine is about the same as that of the Jacquard machine, and it might be called a simplification of it. In the Dobby machine the pattern is obtained by means of little pegs, which according to the requirements are placed in the holes of the bars of a lath work. The bars correspond to the cards of the Jacquard machine.

The chief difference between the systems of the two machines lies in the details. In those Dobby machines which are actually in use the reeds are lifted up and pressed down by means of cams, which are placed on the cam shaft and are connected with the treadle by rods which pass across the warp. Rods which are thus placed are always inconvenient, because they have to be taken down each time that a new warp is to be placed.

One of the most serious qualities of the machine represented in the figure below is that it abolishes the treadles and rods. But its most remarkable advantage is that all its movements are positive. The lifters, A and A^1, and their loopholes, as well as the lath work and its pegs, which are destined for the formation of the pattern, and the racks which carry it, remain as in the ordinary machines; but instead of connecting the reeds or lifting bars by means of straps, their ends project outside of the frame, and are fastened by the rods, E, E', which are furnished with sliding loops, to the toothed sectors, C, C'. These sectors catch into an intermediate wheel, D. The lever, M, is fastened to the same shaft as the sector, C, and is lifted up and pressed down by the rod, N, which is moved by a crank placed on the cam shaft. It is evident that when the rod, N, is placed outside of the frame, it is entirely out of the way and does not incommode the warp.

The two lath works are moved in the ordinary manner by cylinders, which are mounted on a carriage, and which act upon each other by means of the toothed wheels, G, G'.

This carriage has an alternative movement, and is displaced to the left or to the right after each reeding. When the carriage is pushed toward the right, the rack wheel, F, is turned by the action of a catch, the two cylinders describe a fraction of a revolution, and bring new bars of each lath work in the desired position to act upon the bed plates of the machine.

The movement of the carriage is obtained by means of an elbow lever, L, which is fixed on the shaft carrying the sector, C, and the lever, M, in the manner indicated in our picture.

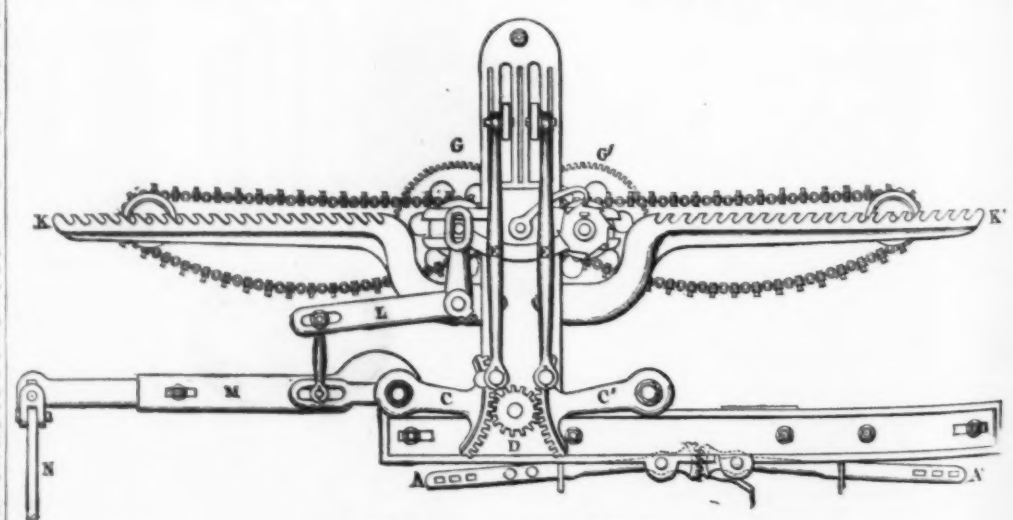
From this description it is apparent that, when the lever, M, is lifted up by means of the crank of the cam shaft, the lifters and combs which are moved by the reed and lifting bar at the right are also lifted up, while those which are moved by the reed at the left are pressed down, inversely to the manner which is determined by the position of the pegs in the bar, which latter then acts.

This improved arrangement is due to Mr. Ainsworth, of Preston. The constructors, Messrs. Willan & Mills, of Blackburn, furnish machines which are constructed in the above-described manner, and contain up to thirty lifters.

THE RAILWAY TUNNEL BETWEEN FRANCE AND ENGLAND.

AN excursion was made a few days ago by M. Léon and M. Varroy, the Minister of Public Works, accompanied by M. Ribot, Deputy, and Fernand Raoul-Duval, civil engineer, to Sangatte, near Calais, for the purpose of visiting the soundings which have been undertaken by the Submarine Tunnel Company between England and France. The excavations have been commenced at some distance from the village, at a spot where the cliffs have an altitude of seventy feet above the level of the sea at high water. A point has been chosen where the rocks of gray chalk which have to be traversed by the tunnel come to show their heads at the surface of the soil. On the opposite shore similar borings have been, as is known, begun, so that the works are proceeding simultaneously.

The soundings that have been made during the last few



THE DOBBY MACHINE.

years demonstrate that the base of the channel consists of a compact mass of chalk, resting on banks of slate. This mass, which is easy enough to pierce, is said at the same time to sufficiently resist infiltration. It would, therefore, present a substance excellently adapted for perforation. But what yet remains to be proved is whether the succession of these chalk layers will not disclose some irregularities or ruptures which would render the enterprise impossible. That is why, before commencing the definitive works, it was necessary to make an attentive study of the ground by means of trial excavations. It is now five years since the company, which had obtained the concession for the tunnel, began the first borings at Sangatte. But only since last year have the works been prosecuted with any activity.

The chairman of the company was originally M. Michel Chevalier, but since his decease the place of the great economist has been taken by M. Léon Say. The period allotted for the trials was not to have exceeded five years; but as, according to the terms of the concession, the Government was authorized to prolong this term by three years, the Minister of Public Works did not hesitate to accord this extension. However, before making a formal engagement, M. Varroy wished to examine for himself what had been done. The shaft has now reached a depth of nearly two hundred feet, or about one hundred and thirty feet below the level of high water. It has a width of ten feet, and is lined with oak, so that the water cannot penetrate very freely, not more than seventeen gallons a minute. This water is not salt, which is thought to prove that the layers hitherto traversed have their point of contact sufficiently far from the shore to prevent the sea from ascending the shaft. It is intended to sink to a depth of three hundred feet, and then a gallery will be excavated in the direction of England. Up to the present the engineers are highly satisfied with the results obtained, as no irregularities have been discovered, which is considered a good augury for the success of the enterprise.

Unfortunately, with the greatest exertions on the part of the engineers, it is impossible to proceed at a quicker rate than twenty inches a day. Nevertheless in eighteen months or two years enough progress will have been made to arrive at a perfect understanding about the possibility of the undertaking. It is stated that the work will not fail through lack of funds.

THE RIGI RAILROAD.

IN the year 1804, the well-known geographer, Heinrich Keller, from Zurich, on ascending to the summit of the Rigi Mountain, in the heart of Switzerland, discovered one of the finest panoramic displays of mountain scenery he had ever witnessed. To his enthusiastic descriptions some lovers of nature in Zurich and Berne listened with much interest, and in the year 1815 Dr. Abel, Mr. Escher von der Luith, Aulic Counsellor Dr. Horner, who is known as a circumnavigator of the globe, and others, in connection with Heinrich Keller himself, subscribed money to the amount of 2,000 marks ($500) for the purpose of building a hotel on the top of the mountain overlooking the view. This hotel was simple enough, being only a hut such as is to be found in abundance in the Alps, and which are built by the German and Austrian Alpine clubs. At present the old hotel is replaced by another more comfortable building, which is rendered accessible by a railway which ascends the mountain. M. Riggenbach, director of the railway works at Olten, was the projector of this railway, which was commenced in 1869 and completed in the spring of 1871. Vitznau (1) at Lucerne is the starting point. The ascent, at first gradual, soon increases one in four—(Mont Cenis railway only one in twelve). After a quarter of an hour the train passes through a tunnel 240 feet in length (2), and over an iron bridge of the same length, by means of which the Schnurtobel, a deep gorge with picturesque waterfall, is crossed. At station Freibergen (3) a beautiful mountain scene presents itself, and the eye rests with delight upon the glittering ice-covered ridge of the "Jungfrau," the "Monk," and the "Eiger." Farther up is station Kalthad (5), where the road is divided in two branches, one of which goes to Scheideck. About ten minutes from Kalthad is the so-called "Kanzli" (4770 feet), an open rotunda, on a projecting rock, from which a magnificent view is obtained, similar to that from Rigi-Staffel, but with a more picturesque foreground. The next station is Staffelhöhe (6), from which the railroad leads very near to the abyss on the way to Rigi-Staffel, and from this point it reaches in a few minutes its terminus, "Rigi-Kulin" (8).

This is 5,905 feet above the sea, the loftiest and most northern point of the Rigi group, the entire circumference of which is twenty-five to thirty miles, and is covered with verdure to the summit. Its northern side makes a precipitous descent into the lake of Zug. The new hotel, with the older adjacent buildings, is situated about 130 paces below the summit, sheltered from the north and west winds.

The gauge of the Rigi railway is the same as that of most ordinary railways. Between the rails runs a third broad and massive rail, provided with teeth, on which a cog-wheel under the locomotive works. The train is propelled upwards by steam power, while in its descent the speed is regulated by an ingenious mode of introducing atmospheric air into the cylinder. The carriage for the passengers is placed in both cases in front of the engine. The larger carriages have fifty-four seats, the smaller thirty-four. But only one is dispatched at a time. In case of accident the train can be stopped almost instantaneously. A view of the railroad and stations is seen in the annexed picture.

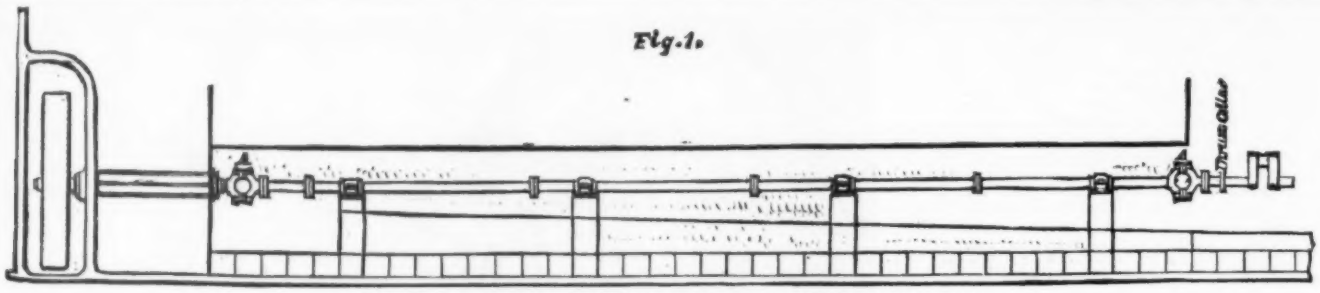
THE RIGI RAILROAD.

FLEXIBLE COUPLINGS FOR SCREW SHAFTS.

THE frequency with which serious breakdowns at sea are caused by the fracture of screw shafts is a matter of notoriety, and there appears to be little doubt that in a number of cases these fractures arise from the rigidity of the series of lengths of shafting as coupled up by the flange couplings generally used.

The flexure of the stern part of the hull of a vessel which takes place in a heavy seaway, or which is induced by alterations in loading, involves, under ordinary circumstances, the corresponding flexure of the screw shaft, except in so far as this is relieved by the slackness of the bearings, and this flexure combined with the rotary motion of the shaft (which causes the direction of flexure to be continually changing) undoubtedly exercises a destructive influence on the shaft itself. Of course, the extent of the injury thus inflicted depends upon many things, such as the greater or less rigidity of the vessel, the accuracy with which the shaft bearings are arranged, and the material of which the shaft is made. Steel shafts probably suffer less than iron, not only from the increased resistance of the material, but also from the fact that the use of steel allows of a somewhat smaller diameter of shaft to be used for a given power, the

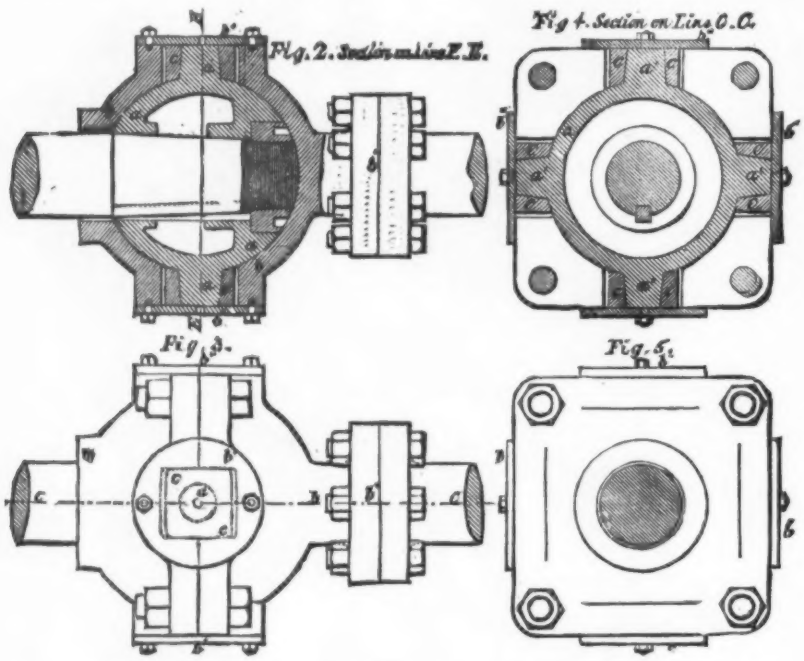
Fig. 1.



FLEXIBLE COUPLINGS FOR SCREW SHAFTS.

injury inflicted by a certain deflection in this smaller shaft being, of course, less than in a larger one.

To get over the trouble to which we have alluded, Mr. S. W. Snowden, of Dublin, proposes to place on the line of screw shafting one or more flexible joints, which will enable the shaft to adjust itself to the springing of the vessel, and he has designed and patented for this purpose a special form of joint, of which we now annex illustrations. In our engravings, Fig. 1 shows a length of screw shafting fitted with two of these joints, A A, one at each end (although it would probably be desirable to fit the joints at some intermediate points also), while Figs. 2 to 5 show the details of the joint itself. Of these latter views, Fig. 2 is a longitudinal section of one of the ball and socket joints; this section is taken on the line, B B, in Fig. 3, which is a plan of the ball and socket joint; Fig. 4 is an end elevation of the joint; and Fig. 5 is a section on the line, C C, Fig. 2.



FLEXIBLE COUPLINGS FOR SCREW SHAFTS.

In the detail views *a* is a ball fixed upon one portion of the shaft, the end of the latter being coned to receive it. The ball is secured to the shaft by a key or keys, and a nut is screwed on to the end of the shaft, filling a recess formed to receive it in the ball. The ball fits a cup, *b b*, which is formed in two parts firmly held together by bolts, one part being fixed to the adjoining length of shaft by a collar, b^1. This collar is secured to a corresponding collar upon the shaft by bolts, as shown. The ball, *a*, has upon it four projections, a^1 a^1 a^1 a^1, which receive upon them the four driving blocks, *c c c c*. These driving blocks enter into corresponding recesses in the cup, *b*, which recesses they fit with just the amount of slackness to permit the necessary play; while b^{11} b^{11} are cover plates bolted on to close the recesses containing the driving blocks. These cover plates can be removed at any time when the driving blocks require alteration or renewal.—*Engineering.*

THE GAS WORKS OF BRUSSELS, BELGIUM.

THE City of Brussels has been lighted with gas since the year 1819 (Aug. 24). The number of street lamps first used for the public lighting was 700, which had increased to 1,200 in 1839; while at the present time there are 4,400 public lamps in use. The first concession was granted to a private company; but in 1844 it passed into the hands of the Imperial Continental Gas Association. When the concession was to be renewed, in 1873, the municipality determined on having the works removed from the city; and subsequently resolved upon taking the gas supply into their own hands. An extensive site, comprising nearly 25 acres of land, was purchased at Lacken, a suburb of Brussels, and upon this it was arranged to erect gas works. It was not until December, 1874, that the new works were commenced, and they were carried out according to the plans and under the superintendence of M. Somzé, the Engineer to the Municipality. By the month of August in the following year the works were sufficiently complete to commence making gas, though they were not by any means finished. The cost of the new works, including the amount expended on the purchase of the old establishment, and the outlay incurred in thoroughly overhauling and renewing the service pipes, was about £490,000. The price of gas is now 20 centimes per cubic meter, which is equal to 4s. 8d. per 1,000 cubic feet. At the beginning of the present year there were in use 10,997 meters, and the total number of consumers supplied was 163,000.

The new works are situated near the Schaerbeek Terminus and the Willebroeck Canal, and with these they are connected by lines of railway. The annual consumption of coal amounts to 60 millions of kilogrammes; and about 40 millions kilogrammes of coke and other residuals are sold. The most important portions of the works have been constructed in such a manner as to be capable of producing 30 million cubic meters of gas per annum. This year the production may be estimated at 17 million cubic meters.

The principal buildings are the retort houses and coal stores; the purifier houses, with the annexes; the gasholders, workshops, and offices.

The retort houses, four in number, are parallel with each other. Each house contains four groups of eight beds of retorts; and each bed heats seven retorts; consequently there is a total of 896 retorts. The distillation of the coal lasts for a period of four hours, and a bed of retorts produces about 1,400 cubic meters of gas daily. The mouthpieces of the retorts are closed by a new kind of lid, with tightly fitting joints, which do not require any cement. The heating of the retorts is done by coke only; the air that is consumed in the fire grate being previously heated in galleries disposed under the beds. The arched roof of the furnace and the retort chambers is constructed of hollow fire bricks, forming an air space to prevent the dissipation of heat. The ascension pipes are connected to the horizontal receiving main by rectangular bends, so that all the pipes are easily accessible. The hydraulic main is of much the same form as a quarter of a circle; the upper side being flat. It is separated in the length by a sheet iron riveted to the upper side. Between the end of the sheet iron and the bottom of the hydraulic main a space of two inches is left, so that the tar, etc., collecting at the lower part of the main is easily drawn off without interfering with the working.

From each hydraulic main the gas passes through a series of conducting pipes, 15¾ inches in diameter and 492 feet in length, for each group of 16 beds of retorts, and from thence through cascade scrubbers, of which there are 16, having a height of 36 feet and a diameter of 8·2 feet. They are worked in pairs. In this apparatus the cleaning of the gas begins, and it is finished in a large scrubber, a collecting one, 19·7 feet in diameter, and 78·8 feet high. The gas arrives at the center of the base of each scrubber, and passes over and under flat disks held between pairs of hollow opposed disks kept cool by surrounding water. After traversing these it passes through four layers of coke kept continually damp by sprays of water descending from a cistern at the top of the scrubber. The water that has passed into the large scrubber is driven up by means of a gas engine into the cisterns of small scrubbers, and by this double circulation the water is charged more and more highly with ammoniacal products, which are driven off with the gas, and at last it comes to the degree of saturation required for its treatment. The scrubber cylinders, which are of sheet iron riveted together, are provided with doors for the renewal of the coke; and at the top the water cisterns are surrounded by an ornamental wood cover. The passage of the gas through the large scrubber is regulated by the purity of the gas after its exit from the other scrubbers, the deposition of the naphthaline being facilitated by a jet of steam. The total surface of condensation, including the condensing pipes on the retort house walls, is nearly 15 square feet per 1,000 cubic feet of gas made in 24 hours.

The coal stores are five in number, and they are placed alternately with the retort houses. Each will contain 1,600 tons of coal. Railways, crossing them in their lengths, allow of the coal being stacked under the most economical conditions. The coals used are from the Borinage, Ruhr, and Newcastle basins. At times Scotch coals are employed, when it is desired to increase the illuminating power of the gas. Belgian coals are sent in railway trucks; foreign coals by boats.

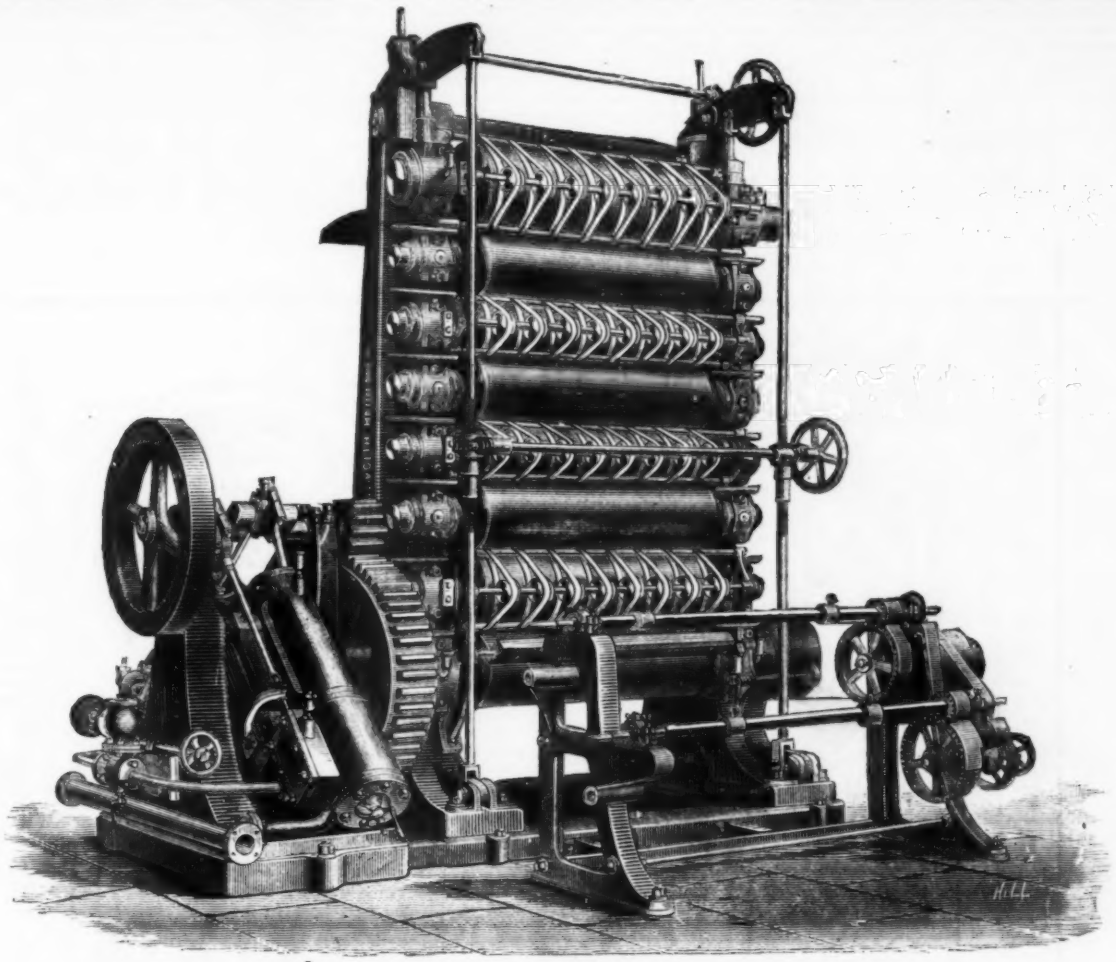
From the scrubbers the gas is drawn by two of Schmitz's exhausters, with automatic regulator, supplemented by a Körting one. They are arranged so that the gas may be delivered either into the gasholders or into the city mains, and they are of such a power that only one engine is sufficient during the summer season. The speed of the engines is regulated by indicators with electric signals. The motive power for the exhausters is supplied by three Galloway boilers of 20-horse power.

The purifying materials employed are lime and oxide of iron. There are 26 purifiers, 6 meters long and 3 meters wide. Each is provided with a by-pass valve, and other valves divide the purifiers into series and batteries. Usually the gas passes through three oxide purifiers, and afterward through a lime one. The purifiers are disposed in two parallel rows in a special building provided with a steam traveling crane. They have the ordinary external case and water-jointed cover, but, in addition, they have an internal frame which supports the trays. When it is desired to change a purifier, these frames are lifted out with their trays, and the whole is transported by the traveling crane to a place where the revivification takes place by means of a forced current of air. This arrangement reduces the purifying labor to a minimum. A De Nayer boiler of 70-horse power supplies the motive power.

On its way to the holders the gas passes through three station meters, each having a measuring capacity of 1,765,000 cubic feet per day, at the rate of 100 revolutions per hour, and from these it passes into four holders, three of which have a capacity of 390,000 cubic feet each, and the other of 780,000 cubic feet. A fifth one, of a capacity of 780,000 cubic feet, is about to be erected. The tanks are entirely above ground. The three smaller are of sheet iron riveted together with T-iron hoops throughout their whole height. They are 33 ft. 6 in. high, and 117 feet in diameter. The larger one, as well as the holder which is not yet erected, is 33 ft. 6 in. high and 164 feet in diameter. Its construction is a special one. The lower 17 feet are composed of a series of superposed channel irons, riveted together with the flanges outward, and every alternate ring of the lowest six rings is strengthened by T-iron hoops. The joint between two channel irons is secured with iron cement. The upper part of the tank is of sheet iron. The holders are single lift, and are constructed without any trussing for the roof, which, when the holder is landed, is supported on wooden framework. The holders are externally stayed with vertical channel irons, and internally have angle iron gusset stays at the top. At the top and bottom of the larger one there are box girders, which act as stiffeners, and also, being filled more or less with water, are employed to adjust the pressure. Gas thermo-siphons are employed to maintain a suitable temperature of the water during winter. The peculiar feature of these holders is that the gas enters and leaves at the top, instead of, as is usual, at the bottom of the tank by underground pipes. At the two opposite ends of the diameter are fixed two double tubes, one inside the other, the space between being filled with water, to make a hydraulic joint for a pipe which slides therein, and which, being fixed to the top of the holder, rises and falls with it. The gas enters the bottom of the internal tube after passing through a stop valve, rises therein, and enters the holder through an elbow fixed and strongly stayed thereto. At the top of the moving pipe is a disk valve, so that by this and the valve previously mentioned the gas may be wholly shut off from the telescopic arrangement, either at the exit or entrance side, both being alike. Many advantages are claimed for this system, more particularly with reference to facility for repairs and cleaning, and non-liability of the supply pipes to be broken by contraction or settling of the tank foundations. The arrangement has also the advantage of placing within view all the pipe connections for the entrance and exit of the gas.

The coke which is produced is chiefly sent to Flanders. That sold for private requirements in the city is subject to special treatment, which consists in breaking and separating it according to its size. Two coke breakers worked by a gas engine of 6-horse power will deliver 11,000 bushels of coke every day. The breeze produced by this operation is used for making agglomerated tar blocks, manufactured in the works, and used for heating the retorts. A compressed fuel machine in one of the coal stores will turn out 20 tons of this fuel per day. The ammoniacal liquor is either formed into ammoniacal sulphate, or concentrated in Solvay's distilling apparatus.

I must say that the lighting of the City of Brussels is not quite so easy as in other towns; indeed, it is a very uneven place. The difference of level between the lowest part and the highest is 74 meters, or 297 feet; hence the necessity for having two mains, one for the lower and the other for the higher district. Beyond this six Giroud's regulators are fixed at a point half way between the two levels, in order to have the lighting of these parts of the city perfectly well regulated and uniform. The gas therefore passes into the town by two mains, one of 23·6 inches in diameter for the higher parts, and the other of 33·5 inches for the lower parts. The joints, which are made on M. Somzé's principle, are of conical form, rendered gas-tight by a ring of India-rubber placed in a groove in the socket portion of the joint. The entire length of mains in the city is 159,720 yards, and the diameter varies from 3 to 33·5 inches.—*Journal of Gas Lighting.*



IMPROVED CALENDERING MACHINERY.

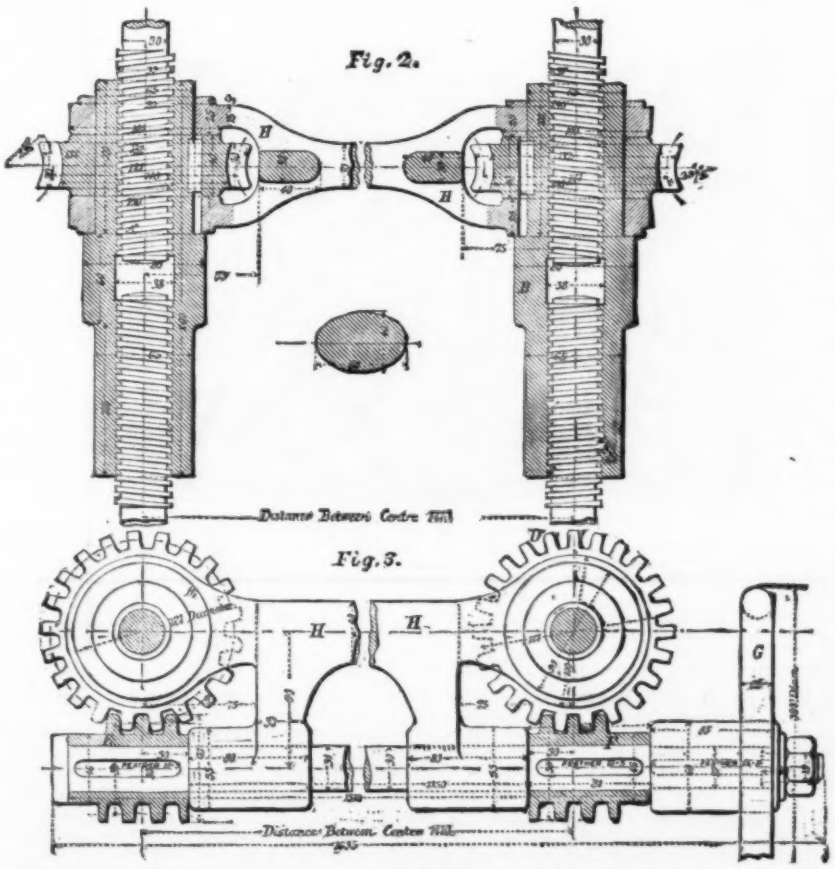
IMPROVED CALENDERING MACHINERY.

OUR engraving represents an improved paper calendering machine, manufactured by Mr. F. Voith, of Heidenheim, represented by Mr. P. Pfleiderer, of 37 Farringdon Street, London.

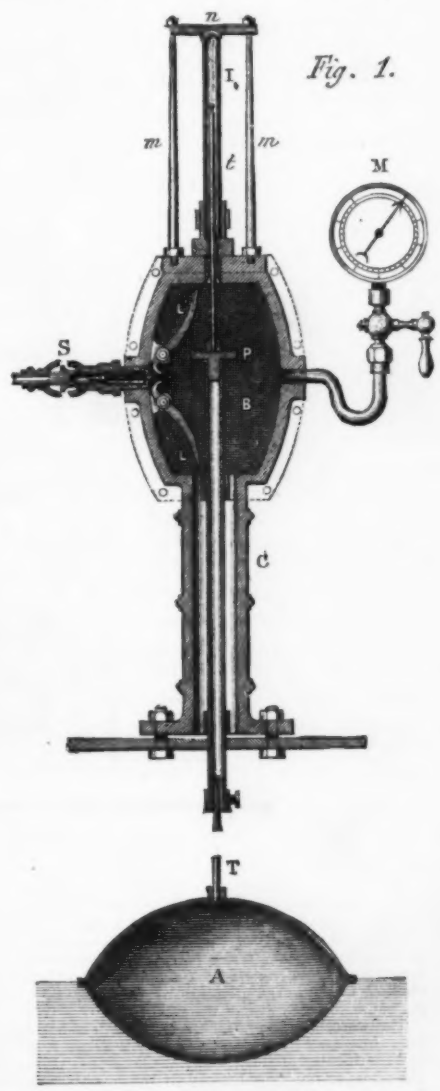
The machine represented is an eight-roll calender with an engine attached; this engine has two cylinders placed at right angles, so that it can be started at any point. The nuts are provided with wormwheels, which gear into worms mounted on one shaft, extending across the machine, and terminating in a handwheel. The bearings of this shaft are cast in one piece, and are supported by the nuts in which the vertical rods work. A third improvement is effected by a modification of the lifting screws. For these long flat bars are provided at intervals with slots, increasing in length from the top to the bottom. Bolts connected with the sliding bearings pass through the slots in the bars, so that each roll can be raised consecutively, and any one of them can be removed without disturbing the others.—*Engineering.*

ALARM WATER GAUGE.

THE water gauge of Mr. Gerkinet Ledent, of Herstal (Liége), which is represented in the annexed cut, consists, first, of a floater in the shape of a hollow lens, A. This lens is surmounted by an iron link, T, which bears on top a little plate, P, upon which rests a ram, *t*, moving in a glass tube, I. The link, T, goes through a column, C, bolted upon the boiler and ending in a box, B, which is closed by a bolted cover. Two levers, L and L^1, are connected by joints with the wall of this box, and their smaller arms act upon the alarm whistle as soon as their larger arms are touched by the little plate, P, which happens always when this plate has reached one of its most extreme positions, corresponding respectively to a want or a surplus of water. The box, B, is furnished also with a tube connect-



IMPROVED CALENDERING MACHINERY.



ALARM WATER GAUGE.

ing it with the steam gauge, M, and with two standards, *m*, which are connected by a cross piece, *n*, and are destined to support the water gauge tube, I.

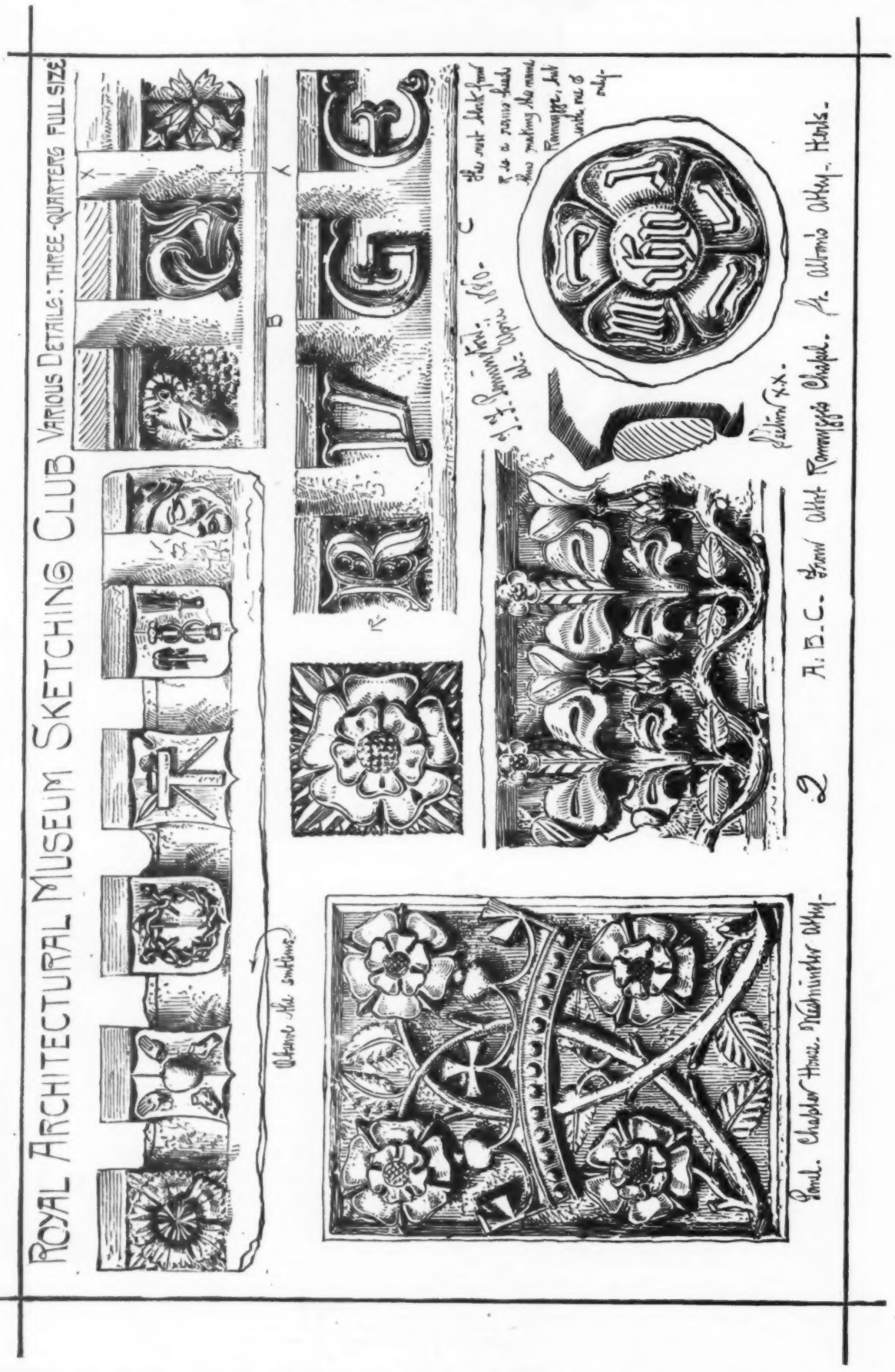
The inventor vindicates the following advantages in favor of his apparatus. The floater and the water gauge are so constructed that they can move freely. The apparatus contains no part which is subjected to a rapid deterioration, it needs no repairing, and its good working order cannot be modified by the heat nor by water, which has a perfect uniform temperature.

If the glass of the tube should break, the working of the alarm whistle would not be interrupted, and the ram, *t*, forming a miter, would prevent the steam from escaping. The glass tube can be quickly and easily replaced. The use of Gerkinet Ledent's water gauge does away with tamping boxes, and those conic adjustments, which, when too much choked, paralyze the mobility of the ram, and when too lax cause the escaping of the steam.

The water gauge of Mr. Gerkinet Ledent has been for a long time used by the John Cockerill Society, of Seraing, and certificates of this society declare that this apparatus, placed upon the two boilers in the construction hall, has been observed during ten months, and has been found to work to the greatest satisfaction. In several cases it has been found that when the glass tube broke, it could be replaced with perfect ease and without trouble. Among the other Belgic manufactories in which this water gauge is used we mention that of the Société d'Espérance and the Charcoal Manufactory of Abhoz. These two manufactories as well as the French manufactories report that the application of the water gauge to their boilers has been a great success.

DETAILS FROM ST. ALBANS.

WE give another of Mr. T. F. Pennington's valuable sheets of sketches, from the examples of carvings collected at the Royal Architectural Museum, Westminster. This drawing was finished on the spot in pen and ink, and it illustrates several portions of the interesting and elaborate chapel of Abbot Ramrygge, at St. Albans Abbey. The panel is from the Chapter House, Westminster.—*Building News.*


ROYAL ARCHITECTURAL MUSEUM SKETCHING CLUB VARIOUS DETAILS: THREE-QUARTERS FULL SIZE
A. B. C. from Abbot Ramrygge's Chapel. St. Albans Abbey. Herts.
Panel. Chapter House. Westminster Abbey.

FROM a comparison carried on by P. Miquel, in Paris, from December, 1879, to June, 1880, it seems that every increase of atmospheric bacteria is followed, in about eight days, with an increase of the deaths from infectious diseases.

AMERICAN CEMENTS.

To the Editor of the Scientific American:

In your issue of August 28, page 136, you favor your readers with extracts from a paper read by Mr. F. O. Norton at a recent convention of the American Society of Civil Engineers, and as you state that the paper was an "interesting" one, and as the SCIENTIFIC AMERICAN is read by a large class of business men throughout the country, who entertain great respect for your opinions, and are also interested in the question of cements, we hope you will consider it as only fair, at least, if we ask you to allow your readers a little space for a friendly discussion as to the points raised in Mr. Norton's paper.

Mr. Norton first asserts that the "*principal deposit* of magnesian limestone, producing cement possessing hydraulic energy, occurs in the town of Rosendale, Ulster County, N. Y."

Now, there are several localities in this country that contain as much if not more cement rock "possessing hydraulic energy" than can be found in the said town of Rosendale, among which may be mentioned the enormous deposits at or near Louisville, Kentucky; at or near La Salle and Utica, Illinois; also those at Milwaukee, Wisconsin; and last, but

not least, the single deposit in Erie County, New York, at and near Buffalo, which contains no less than four hundred and twenty millions of barrels of cement, enough of itself to supply the world for some time to come. And as to the question of the particular deposit "possessing hydraulic energy," we will dispose of that by simply referring to Gillmore's "Treatise," page 291, table 40, containing tests of various cements, showing the tensile strength of each. It will be seen that only two of the brands we have named as outside of the "principal deposit" were represented in Mr. Gillmore's table, namely, Akron, Erie County, New York, and Utica, Illinois. Yet these two brands, when mixed with one part cement and two parts sand, exceeded in tensile strain any and all the Rosendale brands, and these two brands are not considered as the *very* best in the Western market either.

Now, in regard to the "reputation" of the "principal deposit," and its being sold in most all of the large markets of the United States, we will state that the cements that are manufactured at Buffalo and Akron, Erie County, New York, and at Louisville, Kentucky, and Utica, Illinois, and Milwaukee, Wisconsin, supply ninety-nine per cent of all the natural cements consumed in Ohio, Michigan, Indiana, Illinois, Wisconsin, Minnesota, Nebraska, Iowa, Kansas, Missouri, Colorado, Kentucky, Tennessee, and the western half of New York and Pennsylvania.

This leaves about one per cent. for the "principal deposit" out West.

One other feature of Mr. Norton's paper deserves notice.

He endeavors to prove that Rosendale cement, if used with one part cement and one part sand, is cheaper and better than Portland cement with one part cement and two parts sand. He shows that a barrel of mortar composed of one part Rosendale cement and one part sand will cost 68 cents, while a barrel of mortar composed of one part Portland cement and two parts sand will cost $1.22, and that the former will withstand a tensile strain of thirty-four pounds to the square inch greater than the latter, and therefore the "Rosendale is economical."

Now, this looks plausible enough, and we do not like to disagree with Mr. Norton on every point, yet we fear we must in this instance also.

Let us suppose a case. Mr. Norton wants a new coat. He presents himself to his merchant tailor and makes known his wants. The tailor takes down two pieces of cloth and says, "Mr. Norton, here are two pieces of cloth. A coat made up from one of the pieces will cost you $20. It is high, I know, but you see the goods are first-class, 'all wool.' Now I will make you a coat off the other piece for $10; both look well. Few persons could tell the difference on the street. To be sure the cheap coat will be nearly *all cotton*, but what of that? It will be *just as large* as the good one, and just as *good a fit*. And now, why is it more 'economical?' I make up coats off this cheap piece and send them over to Boston and all along the Erie Canal—in short, all over the country. Now, isn't that good proof that the $10 coat is just as good as the $20 one? Why, man, if you will only just take two thicknesses of cloth (*i. e., use half the sand*), the cheap coat will '*stand greater tensile strain*' than the $20 coat will."

Let a mason take one barrel of Portland mortar at $1.22 and one barrel of Rosendale mortar at 68 cents, and with each lay a strip of sidewalk. Don't you think that by the time gentle spring has come around, and he sees that his cheap-mortar job has gone all to pieces, he will begin to think that, instead of his saving 54 cents, he has thrown away 68 cents, along with much more than that amount in labor? Mr. Norton says that "up to within a very short time" all the important masonry in this country "has been laid with American cement." What does he mean by "up to within a very short time?" If Rosendale cement has given "such excellent satisfaction for fifty years," why not for ever?

We answer, because these fifty years of experience has taught the people that the only cement that can withstand the extremes of heat and cold in this country is Portland cement, and we do not hesitate to say that, unless the manufacturers of common American cements improve the quality of their goods, they need not expect to hold their own against the Portland cements in important works of masonry in the "great future" of this country.

It is well known that the foreign Portland cements are manufactured artificially—that is, the ingredients, clay and lime, are brought together and mixed in certain proportions, then calcined and ground; and it was only after several years of tedious and costly experimenting that the manufacturers learned that, to produce good results, a rigid adherence to certain fixed proportions of the two ingredients—clay and lime—was absolutely essential.

Another important feature to be observed is the calcination. In order to produce a true Portland the calcination has to be carried to that degree and duration of heat as to cause the cement, when ground, to weigh one hundred and ten to one hundred and twenty pounds per struck bushel, whereas Rosendale cement, as now manufactured, weighs but eighty to eighty-five pounds per struck bushel.

It is not impossible to produce a cement from natural cement rock equally as heavy and strong, and as capable of resisting the effects of heat and cold, or the gases in sewers, as any foreign cements can do, but the rock must be selected that contains essentially the same proportions of ingredients that are found in the true Portlands. When these conditions obtain, then a natural cement is equally as good as a Portland, but not otherwise.

The following analysis will serve to illustrate our meaning quite plainly, by taking one of the best brands of Portlands as a standard. The *essential* ingredients only are given:

By whom analyzed.	"K. B. & S." Portland. E. T. Cox.	Buffalo Cement. E. T. Cox.	Rosendale Cement. E. C. Boynton.
Silicic acid.....	31·43	32·86	43·11
Alumina.....	10·80	10·40	3·65
Lime and magnesia.	57·77	56·74	53·24
	100·00	100·00	100·00

U. CUMMINGS.

Buffalo, August, 1880.

FROM experiments made on young soldiers by M. Marey, it appears that after a gymnastic course the men breathed about twice as much air as before, and although the number of respirations is reduced from twenty to twelve per minute, the amplitude of these respirations is more than quadrupled. At first the respiration is considerably modified by running at the rate of six hundred meters in four minutes, but after from four to five months' practice at this kind of exercise there was no perceptible effect.

THE CONSUMPTION OF PAPER.

IF Liebig, in his day, gauged the civilization of a country by the quantity of soap consumed, we are more fully justified, in our age, in using paper as a measure of culture. This is most plainly demonstrated by the total production of each separate country, and the consumption of paper per head of its population. The United Stands stands first on the list, producing 460 millions pounds, and importing besides about 4 millions more; next follows Germany with 452 millions, England with 402, France with 296, Austria with 216, Italy with 112, Russia with 72, Spain with 68, little Belgium with 54, Switzerland with 32, Sweden with 30, the Netherlands and Portugal each with 16, and Denmark with 10 millions pounds. Greece, Roumania, and Turkey manufacture almost no paper, and import together about 26 millions. Asia, Africa, Australia, Brazil with South America, Mexico, Central America, and Canada, together produce only 26 millions pounds, but import 48 millions besides. Consequently the total quantity of paper manufactured by the European process is 2,280 million pounds, which is used by only 364 millions of souls of a total population of 1,423 millions. The remaining two-thirds of humanity either use no paper or use paper made in Asiatic fashion. As regards the consumption of paper per head of population, England and the United States are on the same level, each country using 12 pounds for each inhabitant. In Germany the proportion is 10½ pounds per head, in Switzerland 10, France and Belgium 8, the Netherlands 6, Austria 5½, in Italy, Portugal, and Sweden, respectively, 4 pounds per head. The total value of the 2,280 million pounds of paper produced may be roughly estimated at from £30,000,000 to £40,000,000 sterling. Half of that sum is expended in printing paper.

THE HERDIC COACH.

A SPECIMEN coach of the Herdic Personal Transportation Company was tested recently. It is a queer-looking affair, with immense wheels and long, low body, almost touching the ground. The coach is 10 feet long, 8 feet high, and 4 feet 10 inches wide. The front wheels are 5 feet in diameter, and the back wheels are 3½ feet. The roof of the coach projects outward in the rear for the purpose of protecting passengers from rain and snow, and there is also a protecting cover over the driver's seat in the front part of the coach. The specimen coach has only one door in the rear, which is approached by a broad low platform, apparently designed for the convenience of street boys who like to "hang on behind." This defect will be remedied in the other coaches by constructing double convex doors, extending to the edge of the platform and held shut by a strap under the driver's seat. The doors and the eight windows of the coach are furnished with heavy plate glass.

The body of the coach rests on two solid steel "reaches," furnished with the "Herdic patent axle," by means of which the coach is enabled to run over any obstacle without danger of breaking the poles. The wheels turn on a pivot on the sides of the coach instead of in the center, which removes the strain from the poles and enables the coach to turn around in a very small circle. Ordinary vehicles describe a large circle in turning, but with the Herdic axles the coaches can turn in a circle two feet in diameter. The wheels in turning do not grate against the "reaches," as in ordinary coaches. The patent axles and high wheels and low resting body tend to facilitate the motion of the coach to such an extent that one horse can draw it with its complement of passengers with comparative ease.

A horse of ordinary strength was put to the coach; fourteen full grown men got into the coach, and a driver mounted the box. The horse drew the coach with ease, trotting away with it at a good pace. As the coaches are designed to hold only eight persons, the horses will not be overworked like those on the street cars. The coach is handsomely painted with black paint and varnished. Above each row of windows on the outside is painted in yellow letters, "Reserved Seats, — Cents." Beneath the windows is the following sign: "Limited Coach No. 1, Market Square and Junction."

The interior of the coach is handsomely furnished. The roof is paneled in oak and the floor is covered with linoleum. There are velvet-cushioned seats on either side of the coach for four persons, and more than eight will not be admitted at one time, although ten persons might be seated with comfort. Above each seat is a leather strap, within easy reach, connecting with a gong above the driver's seat. Most of the coaches now building will be furnished with seats of perforated wood instead of velvet. The coach is lighted by a large lantern. It was intended at first to illuminate the coach with gas, but the plan was found to be impracticable. A patented money box, smaller than those used in some of the street cars, is placed beneath the lamp in the front part of the coach. Tickets and change will be furnished by the driver.

The Transportation Company, which received its charter a few days ago, will begin operations about the 1st of September. The main object of the company is to establish a line of coaches or cabs in every part of the city, for the purpose of conveying passengers to points inaccessible to the street cars, at reduced rates. Coaches will run on Broad Street, Delaware Avenue, Allegheny Avenue, and streets not reached by the street cars, and also on the principal streets of the city running from north to south and from east to west. Frankford, Germantown, Chestnut Hill, Darby, and other suburban points will be included, and the principal depots and places of amusement will be reached. It is also the intention of the company to establish a line of extra coaches for picnics, excursions, private pleasure parties, etc., and a number of coaches designed for that purpose are already building.

Each coach will accommodate eight passengers. Special arrangements have been made with a view to facilitating the conveyance of passengers, whereby picnic coaches may be had at any time by telegraphing to the headquarters of the company. The regular passenger coaches may be had at all hours. Up to midnight the coaches will run every ten minutes; after that they will run at longer intervals. They will stop when hailed between crossings. The fare will be five cents, but six tickets will be sold for a quarter. It is the intention of the company to run 4,000 coaches in this city—500 on Broad Street and the remainder proportionately on various thoroughfares. Workshops have been established for the construction of the coaches in the western end of the Main Building, at the Exhibition Grounds, and on the lot adjoining a restaurant on Belmont Avenue. About one hundred men are employed, and the work is progressing rapidly. Twenty coaches will be turned out every day after the shops are in full operation. Wheels for the coaches are making at Wilmington, Chester, Mechanicsburg, and other cities. Mr. Herdic intends to establish similar lines of coaches in all the principal cities of the United States and in several of the European capitals. The work will be pushed forward as rapidly as possible, and it is expected that the enterprise will be in full blast by the first of December.

THE ORIGIN OF THE INDIAN.

THE question of the origin of the Indians, as you are already aware, has occupied much of my time for many years. At the present moment there appears to be a conflict on the question of the possibility of civilizing the race and admitting them as citizens. My impression, since my visit to the Territory of Alaska, has been that the tribes on this coast originally came from China. There are several facts I have observed that have led me to this conclusion:

First.—Recent discoveries in Washington Territory. In digging through a bank for the North Pacific Railroad was found an altar of *Josh*, which was inscribed with characters such as are found in his temples in China, causing considerable excitement among the Chinese workmen.

Quantities of beeswax, as late as 1846, were found washed out of the sand that had the appearance of having been buried for ages. This fact could have but little weight in this statement had not the recent action of the waves of the ocean changed the channel of the great Columbia River and undermined and washed away trees of a hundred or more years' growth, and exposed logs buried in the sands beneath the forests now old and in decay.

Second.—In 1843* a Chinese junk was lost on this coast. Three young men were saved, taken to England, educated, and sent back to their country. Previous to that date Chinese vessels had been wrecked upon this coast.

Third.—The form, physiognomy, traits of character, and color. These resemblances are as prominent between the Indian and Chinaman as they are between any race of Europeans that come to our country.

Fourth.—Resemblance in *traits of character*. For seven years past I have had from four to twelve Chinamen in my employ constantly, and during the whole time over forty different ones. You will bear in mind that for the first six years of my residence in Oregon I worked with Indians, from 1836 to 1842, and had them in my employ on the Columbia and Iroquois rivers for over six years more. During the whole time, I say unhesitatingly, that I have had less difficulty and less perplexity in dealing and working Indians and Chinamen than I have had in working French, English, Irish, or American; they have all been under my supervision and in my employ about in equal proportions, in number, and time. The Indian and Chinaman are alike in patient endurance, in labor, and in disposition, except the Indian's wildness, which may be attributed to the unbounded country which he inhabits, and the confined limits of the Chinaman's country and the arbitrary laws by which he is governed; otherwise I discover no difference in the two races in disposition and in action.

As to their moral or religious disposition. The Chinaman adheres to *Josh*, and has a feast over the cooked or carefully-roasted pig; his charm is the *Josh paper*, the firecracker, the chickens, and sweetmeats, the latter given to the dead as a sacrifice. The Indian has his *Totems*, the eagle, the bears, beaver, wolf, and the muskrat; the horse, canoes, blankets, and cooking utensils go to the dead as a sacrifice. The former in a knowledge of arithmetic is superior to the latter, yet the latter count readily into the number of thousands. The Chinaman has a printed language, and, as a nation, is more extensive and uniform in his knowledge of his language. The Indian has not, but has occupied his successive generations in hunting and exploring the vast continent upon which his frail bark was wrecked in the ages past.—*W. H. Gray, in American Antiquarian.*

THE EARTH AS A CONDUCTOR OF ELECTRICITY.

By JOHN TROWBRIDGE.

THE Observatory of Harvard University transmits time signals from Cambridge to Boston, a distance of about four miles. The regular recurrence of the beats of the clock affords a good means of studying the spreading of the electrical current from the terminal of the battery, which is grounded at the observatory; and the establishment of the Telephone Dispatch Companies in Cambridge, with their various ground connections, gave me a means of studying this spreading. In all the telephone circuits between Boston and Cambridge, in the neighborhood of the direct line between these places, the ticking of the observatory clock could be heard. The ticking heard in the telephones at the various stations has been attributed to the proximity of the telephone circuit wires to the time wires from the observatory. This is evidently an erroneous conclusion, as will be evident from a short mathematical consideration:

The expression for the induction produced in one wire by making and breaking a current in a parallel wire, is

$$R_2 y_2 = \pm M y_1,\dagger$$

in which y_2 represents the induced current, R_2 the resistance of the circuit which conveys this induced current, M the coefficient of induction between the parallel circuits, and y_1 the current in the primary circuit; the interruption of which produces the induced currents. Now $M = \iint \frac{ds\, ds'}{r}$, in which ds and ds' are elements of the parallel wires, and r is the perpendicular distance between them. The value of M in the case we are considering is $M = \frac{R_1^2}{r}$, in which R_1 represents the length of the parallel wires along which the induction takes place, and r is the distance between the wires.

We shall, therefore, have $R_2 y_2 = \pm \frac{R_1^2}{r} y_1$, eq. 1. Now the electromotive force in the induced current, y_2, is very much greater than that of the inducing current y_1, and in order that the current strength, y_2 should be able to develop even a small electro-magnetic effect in the receiving telephone, the coefficient of induction must be increased, or the distance along which the conductors are parallel, the distance between them remaining the same. An arithmetical consideration of eq. 1 will convince one that with telephones of the resistance usually employed, no inductive effect will be perceived by the employment of even ten quart Bunsen cells between wires which run parallel to each other a foot apart for the distance of thirty or forty feet. In order to detect an inductive effect under these conditions, a telephone of three or four units of resistance must be employed. The ordinary Bell telephone has a resistance from thirty to sixty units. For still stronger reasons it is impossible to hear

* See page 40, Gray's "History of Oregon."

† Maxwell's Electricity and Magnetism, vol. ii., p. 309.

telephonic messages by induction from one wire to another, unless the two wires between which induction is produced run parallel to each and very near to each other a long distance. This distance generally exceeds the distance at which the ordinary Bell telephone ceases to transmit articulate speech. The effects which have usually been attributed to induction on telephone circuits are due to the earth connections and to imperfect insulation. There would be no trouble from induction if telephone wires were inclosed in a cable; for a consideration of eq. 1 will make it evident that the telephonic message transmitted over one wire would have no practical effect upon the neighboring wires inclosed with it.

Since the transmission of the time signal service of Harvard College Observatory through all the telephone circuits in Boston and Cambridge is evidently not due to induction, but to tapping, so to speak, the earth at points which are not at the same potential, it was an interesting question to study the extent of the equipotential surfaces formed by the ground of the time signal service circuit at Cambridge and in Boston. I speedily discovered that the time signals could be easily heard in a field an eighth of a mile from the observatory, where one ground of the time circuit is located. The method of exploration was to run a wire five or six hundred feet, to ground it at its two ends in moist earth, and to include a telephone of fifty or sixty ohms resistance in the circuit. On completing the circuit through the telephone and the ground, the evidence of an electrical current was plainly apparent from the ticking which the making and breaking of the circuit produced in the telephone; and the time signals of the observatory clock were distinctly heard. At the distance of a mile from the observatory, and not in the direct line between the observatory and the Boston office, the time signals were obtained by tapping the earth at points only fifty feet apart. At a distance of five hundred feet, directly behind the observatory, no points five hundred feet apart could be found which were not practically at the same potential. The survey was carried to a distance of a mile behind the observatory ground, with negative results. At points one mile from the central line, between the observatory and the Boston office, the time signals could not be heard on the trial wire of six hundred feet. This was to be expected, since the trial wire should have its length increased as the distance from the grounds of the battery increases, in order to permit of one end of the wire touching a point of higher potential than the other.

The theoretical possibility of telegraphing across the Atlantic without a cable is evident from this survey which I have undertaken. The practical possibility is another question.

At no point in our survey did we find an absence of earth currents. The peculiar crackling noises heard in telephones are due to earth currents and not to fluctuations in the batteries employed on telephone circuits; for they were characteristic of the circuits employed by us in which the earth was used as a part of the circuit, and were absent when a battery circuit was closed without the intervention of the earth. The tick produced in the exploring telephone, whenever the circuit was closed, through the ground, was due to earth currents and not to polarization between the copper wire and the moisture of the ground, for it was many hundred times stronger than the polarization effect produced by dipping the copper terminals of the telephone wire in acidulated water. This crackling noise produced by the earth currents in a telephone is a curious phenomenon, and shows that the earth currents have a rapidly intermittent character, which escapes observation by any other instrument than the telephone. A delicate electro-dynamometer for the registration and observation of these intermittent earth currents is much to be desired. In some cases the pulsatory effect of these earth currents was very marked. At no point which we explored were evidences of earth currents absent. They seemed to be more pronounced along water courses.

In a discussion of the earth as a conductor, Steinheil says: "We cannot conjure up gnomes at will to convey our thoughts through the earth. Nature has prevented this. The spreading of the galvanic effect is proportional not to the distance from the point of excitation, but to the square of this distance; so that at the distance of fifty meters only exceedingly small effects can be produced by the most powerful electrical effects at the point of excitation. Had we means which could stand in the same relation to electricity that the eye stands to light, nothing would prevent our telegraphing through the earth without telegraph conductors. But it is not probable that we shall ever attain this end."*

Theoretically, however, it is possible to-day to telegraph across the Atlantic Ocean without a cable. Powerful dynamo-electric machines could be placed at some point in Nova Scotia, having one end of their circuit grounded near them and the other end grounded in Florida, the conducting wire consisting of a wire of great conductivity and carefully insulated from the earth, except at the two grounds. By exploring the coast of France, two points on two surface lines not at the same potential could be found; and by means of a telephone of low resistance the Morse signals sent from Nova Scotia to Florida could be heard in France. Theoretically, this is possible; but practically, with the light of our present knowledge, the expenditure of energy on the dynamo-electric engines would seem to be enormous.

The points made in this paper are as follows:

1. Disturbances in telephonic circuits usually attributed to effects of induction are, in general, due to contiguous grounds of battery circuits. A return wire is the only way to obviate these disturbances.

2. The well-defined equipotential surfaces in the neighborhood of battery grounds shows the theoretical possibility of telegraphing across large bodies of water without the employment of a cable, and leads us to greatly extend the practical limit set by Steinheil.

3. Earth currents have an intermittent character, with periods of maxima and minima, which may occur several times a minute during the entire day. This intermittent character is seldom absent.

Physical Laboratory, Harvard University.

IMPROVEMENTS IN COILS OF THE SIEMENS TYPE.

By G. TROUVÉ.

THE polar surfaces, instead of being portions of a cylinder whose axis coincides with that of the system, are in the form of a helix, so that while turning round they gradually approach the surface of the magnet up to the point where the posterior margin escapes the pole of the magnet. The action of repulsion then begins, so that the dead point is practically avoided.

* "Die Anwendung des Elektromagnetismus," p. 172, 2d ed., 1873.

NEW DIELECTRIC MACHINE.

By the ABBE LE DANTEC.

MR. LE DANTEC has invented a dielectric machine which unites the chief principles of all electric machines hitherto invented, and is a great improvement upon the latest one, constructed by Mr. Carré, two of this latter kind being ingeniously connected in one of Mr. Le Dantec's. The construction of it is as follows:

(1) A plate of gum lac, B, which is rubbed by the hands, reminds us of the first electric machines invented by Otto von Guerike and Hawksbee. A rest, E, isolated by two glass posts, serves as a support for the hands, and if the person who rubs the gum-lac plate stands upon a glass stool he is positively electrified.

(2) A glass plate, A, with its rubber, D, and its iron comb, shaped like a horseshoe, as indicated in our illustration by K, reminds us of Ramsden's machine. This comb, K, which is movable around a horizontal axis, can be placed in the position, K', when it is necessary to set in motion the whole of the machine. It is connected by means of the small chain, H, with an isolated copper ball, which serves as a conductor.

(3) The rubber, D, of the glass plate is carried by a horseshoe and isolated by three glass posts in such a manner that both kinds of electricity can be collected as in the machine of Nairne. One of the supports, F, of the rubber of the glass plate is a Leyden jar, which serves for the condensing of both kinds of electricity, as soon as its outer coating is connected with the ball, G. The electric spark springs over between the ball, G, and the bar, L, and this latter is connected with the outer coating of the Leyden jar, F, when the isolations of the rubber are no longer needed.

(4) When the glass plate has been several times revolved by means of a crank, the motion may be arrested, and the glass plate is then electrified between the two caoutchouc plates, C C'. In turning these latter plates, the united effect of two of Bertsch's machines is produced.

Thus, as above mentioned, we find united in this new apparatus the principles of all the chief electric machines hitherto invented, and Mr. Le Dantec's machine is so constructed that these principles may either be used separately or in connection.

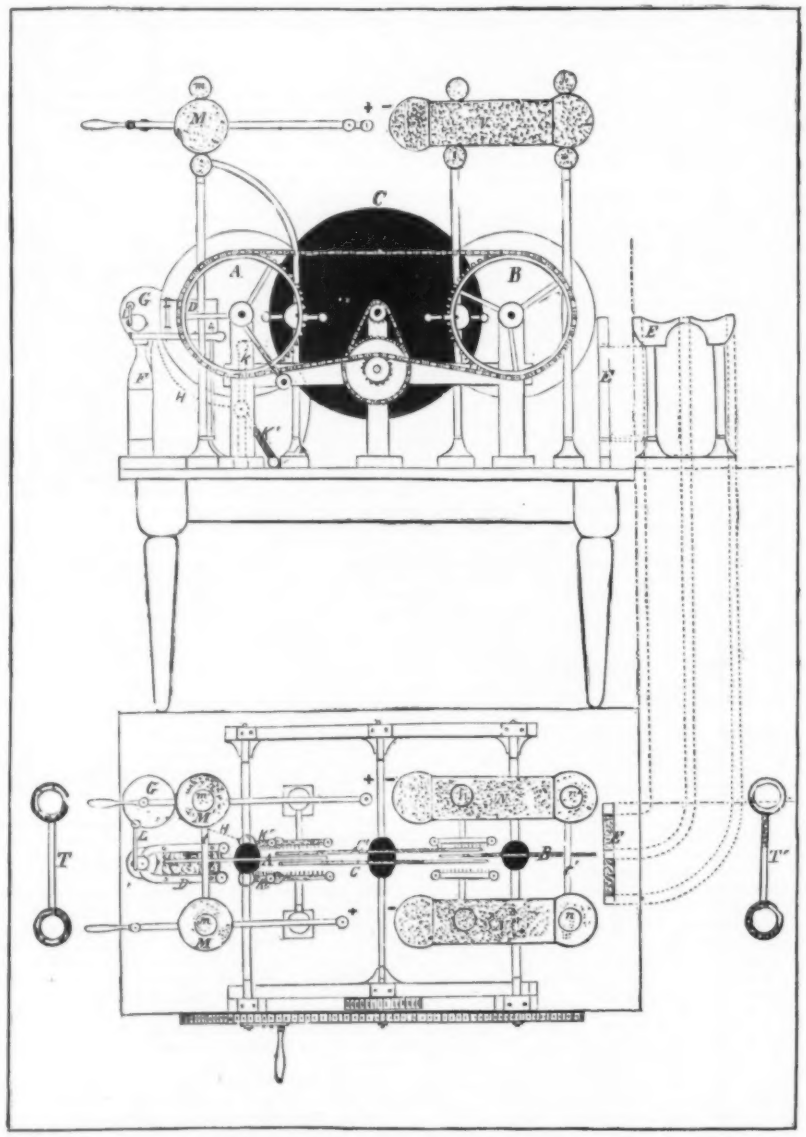
(5) When the glass plate and the caoutchouc plates are turned at the same time, the effect is that of two of Carré's machines.

(6) The following are the advantages of Le Dantec's machine in comparison with Carre's machine. The latter had two weak points. First, if A represents the glass plate, C the gum-lac plate, and M and N the conductors of the Carre machine, then the electricity upon that side of the plate, A, which is opposite to the caoutchouc plate, C, acts only with difficulty upon the comb of the conductor, M, from which it is separated by the thickness of the glass plate, A, and the caoutchouc plate, C, together. Secondly, the negative electricity, streaming from the conductor, M, upon the plate, C, is neutralized by the comb of the conductor, N, in such a manner that the upper half of the plate, C, is in a neutral state. Now, the question occurred to Mr. Le Dantec: Why should not this part of the plate serve to transport positive electricity, as the lower part of it serves to transport negative electricity? This thought led him to make the following improvements: First, he employed two caoutchouc plates, C and C', and, secondly, he introduced between these two plates a plate of gum lac, B, which after it is electrified by rubbing with the hands, produces on its part the same effect as the glass plate does on its. The upper half, viz., of the two caoutchouc plates, is utilized for transporting the positive electricity, the action of which is thus added to that of the glass plate in influencing the combs of the condensors, M and M', while at the same time the lower part transports negative electricity, which assists the gum-lac plate in extracting positive electricity from the combs of the conductors, N and N'.

When, after having mounted all of the above mentioned parts (each of which is a separate electrical machine), the gum-lac plate is added, then the length of the electrical spark is doubled. We have now in reality two complete new machines in juxtaposition.

1. An anterior machine composed of the plates, C, and the conductors, M and N, which utilizes the electricities on the front sides of the glass and gum-lac plates.

2. A posterior machine composed of the plate, C', and the conductors, M' and N', which utilizes the electricities on the other sides of the glass and gum-lac plates. By means of the brass beams, T and T', the first of which is fastened to the knobs, *m* and *m'*, the other to the knobs, *n* and *n'*, the two machines can be connected, and thus one grand machine can be formed.



NEW DIELECTRIC MACHINE.

All these details seem more complicated in appearance than in reality, and permit a great number of interesting combinations, which are highly instructive for the study of the different effects produced by static electricity.

EXPLANATION OF THE FIGURES OF THE ILLUSTRATION.

A, glass plate; B, gum-lac plate; C C', caoutchouc plates; D, rubber of the glass plate, carried by a horseshoe, which is isolated by means of three glass supports, one of which is a Leyden jar. E, rest for the hands, isolated by two glass supports. F, Leyden jar, the inner coating of which is connected with the rubber, D. G, isolated metal ball, serving as a conductor for the positive electricity streaming out of the rakes, K and K', and connected with them by the little chain, H. K K', rakes, which can either be brought into a position opposite to the glass plate, as indicated by K, or inclined downward, as shown by K'. L, movable lever, which serves for the purpose of bringing the negative electricity of the rubber, D, in communication with the positive electricity of the conductor, G. M and N, anterior machine; M' N', posterior machine; *t t'*, glass beams, which hold the system of machines together, at the same time permitting a perfect isolation of the single parts; T T', cross beams of brass, by which the anterior and the posterior machine can be united, and the one of which is fastened to the knobs, *m* and *m'*, while the other is joined to the knobs, *n* and *n'*.

THE ELECTRIC DISCHARGE IN GASES.

A SERIES of instructive experiments on the thermal and optic behavior of gases under the influence of electric discharges, has been recently made by Herr E. Wiedemann. At the end of his paper, in the *Annalen der Physik*, he offers some theoretical observations on the subject, which are to the following effect:

If we now try, on the basis of the foregoing facts, to form a conception of the propagation of electric discharge through gases, we first see that the theory of G. Wiedemann and R. Rühlmann can no longer be held. They consider the discharge to be caused by molecules driven out from the electrode, charged with electricity, and, on meeting other molecules, giving up their electricity to these, and so on. The same theory has been adopted, in somewhat altered form, by Crookes to explain the phenomena described by him, but, for the most part (doubtless without his knowing it), long since published by Hittorf and Goldstein. By this theory the individual outflying molecules must, of course, have velocities corresponding to that of propagation of electricity in gases. But from Wheatstone's experiments on discharge in gases, this is, in any case, more than 200,000 m. or 30 geographical miles. So great a velocity of translation in the direction of the current, the particles certainly have not. When Herr V. Zahn examined the spectral lines in a Geissler tube, the axis of the tube being first parallel to that of the collimator, and then at right-angles to it, he found no displacement of lines, though the dispersion was so great that even 1-40th of the interval between the two D lines could be observed. A displacement of this amount would have corresponded to a velocity of one geographical mile in the direction of the axis, according to Doppler's principle. A velocity of 30 geographical miles would have produced a displacement of nearly the whole width between the D lines. So great an increase of the normal velocity of the molecules was in itself improbable.

In my opinion, the process may perhaps be represented thus: The electricity furnished by the machine, which we may conceive as free ether, is partly accumulated on the surface of the electrodes, and there, by the mutual action between it and the metal parts, is hindered from passage into the surrounding space. Such passage can only occur when its density has reached an adequate amount. At the same time, the electricity in the surrounding medium produces a dielectric polarization, in such a way that the ether envelopes of the individual gas molecules are deformed, and during rotation of the molecules on their axes, maintain always a certain orientation. If a discharge occurs, the sudden change of the dielectric polarization thereby caused is first propagated from the electrode through the ether envelopes of the gas molecules, and so sets them in vibration. A passage of free electricity can then, of course, also take place out from the electrode and from molecule to molecule.

As the light-ray, in the case of phosphorescent and fluorescent bodies, produces, in the ether envelopes of the molecules, oscillatory movements, the kinetic energy of which is considerably greater than that corresponding to the temperature, the same occurs here also. As in that case, the ether-motion causing light is gradually transmitted to the masses of the molecules, and produces heat motions. There is, similarly, in the case of the electric discharge (as a secondary effect) a raising of the entire temperature.

If, (that is to say) through this transference, two molecules of a gas have a greater oscillatory motion than belongs to them according to the normal relations between translatory and oscillatory (rotatory) motion corresponding to their temperature, a part of the internal motion is, on their collision, gradually transformed into the translatory, till finally the normal state is produced.

That, in electrically luminous gases, such an excess of internal motion is actually present, is shown by their low temperature.

The transformation of oscillatory motion into translatory goes on uncommonly fast. I have shown that, by the laws of heat conduction in a tube 1 ctm. wide, a perceptible fraction of the initial energy must still be perceptible in the middle of the tube after 1-1,000 second; none the less, the tube appears in the rotating mirror discontinuously luminous, like Hanover tubes, so that we must hence infer a much quicker transference of the interior motions produced by the current into heat, than the conduction of heat in gases itself.

The vibrations produced by the electric discharges may be so strong that the molecules are decomposed into their atoms; just as in incidence of chemically active rays on chloride of silver, we perceive decompositions, or, in incidence on chlorine, an entrance of this into an active state.

If the oscillatory motions lead to a decomposition of the molecules, the energy required for this is furnished to the molecules by the source of elasticity, and is afterwards, on their reunion, given up to the calorimeter. But whether, in this case, the whole heat produced depends on the latter process, is not to be readily decided. Possibly, a first portion of the passing electricity is applied to an increase of the mean temperature, likewise depending on transformation of the oscillatory motion, and a loosening of the molecules is thereby effected. Then the following portions of electricity complete the decomposition.

Between the productions of heat by a light ray passing through a weakly absorbing medium, and those by electric discharges, there is a remarkable parallelism.

1. If a conically widening beam of light passes through a weakly absorbent medium, the amount of heat developed by it in each cross section is nearly the same, and likewise the amount of heat yielded by the electric discharge in different cross sections is the same.

2. If we increase the intensity of the beam of light, but let it pass, correspondingly, only a short time, an equal quantity is absorbed in the two cases; and the same holds for the discharges when we increase their strength, but diminish their number.

3. If we increase the strength of the optic absorption, say, by increasing the quantity of absorbent parts in an absorbing solution, the quantity of heat developed is correspondingly increased; and similarly, the electric development of heat in a gas is greater in the same section with increasing pressure.

It seems very probable, therefore, that the giving up of the energy in the two cases takes place in the same way, and so that the discharges consist of a transmission of vibrations which give up a part of their energy to the gas particles. We must, in that case suppose that the amplitude which a quantity of electricity, e, produces, is proportional, not to itself, but to $\sqrt{e}$.

But even on this supposition, the phenomena of electric discharge do not allow so fully of explanation as the optical phenomena, because a large number of disturbing influences come in. First among these are the statical discharges of the glass walls, causing a certain polarization of the gas particles, and increasing or diminishing the yield of energy of the discharge.

The very great differences in behavior of positive and negative electricity may perhaps be explained by assuming that the propagation of the latter is alone produced by propagation of dielectric polarizations, whereas that of the former is associated with a passage of the free ether from molecule to molecule, such as Ettings, Nansen, and Hall, have inferred from experiment.

The propagation of the discharge from the negative electrode is subject approximately to the laws of light.

A THEORY OF SEWER GAS.

By P. H. VANDER WEYDE, M.D.

IT has been suggested, and this on very good grounds, that with all the modern sanitary appliances used in large cities, such as waterworks, systems of sewage, improved water closets, various patent traps, and other scientific measures to guard against deleterious gases, we have not only failed to improve the sanitary condition of the people, but we have created epidemics of zymotic diseases directly traceable to sewage gas, and which did not trouble our fathers and grandfathers, who had not the advantage of these improvements, the cesspool being the prevalent institution. The suggestion always impressed us strongly, because even if we make allowance for the lesser knowledge of sanitary laws in olden times, which caused a failure of recognizing the causes of occasionally prevailing epidemics, we know from our own personal experience that the old-fashioned cesspool, notwithstanding its abominable odor, did not produce the dangerous consequences incident to the penetration of the scarcely perceptible sewer gas in our houses. We know even of parties in large cities who for years lived in residences with the cesspool in the house, and who, notwithstanding, never had trouble with zymotic diseases, but even raised a healthy young family, the odor of the cesspool notwithstanding, and this undeniable fact, of which we can cite several instances, led us to reflect about the problem, why the modern scarcely perceptible sewer gas is undoubtedly more dangerous than the exhalations of the old-fashioned very perceptible cesspool.

We believe that the cause must be traced in the abundant use of water under the modern ordinary sewage system, and the total dispensation of its use in the old style cesspool, and that the continual dilution of the effete matter with plenty of water is favorable to the evolution of dangerous gases.

We will try to prove the truth of this theory by the well-known chemical laws prevailing in regard to perishable organic substances.

It is a fact well known to the practical chemist that for setting up alcoholic, acetic, or other fermentation, a dilution with plenty of water is an absolutely necessary condition, so in order to ferment molasses for the manufacture of rum it is necessary to mix it with about ten times its bulk of water; undiluted sirup cannot be made to ferment; in order to cause the acetic fermentation in the common "barrel with wood shavings" process of changing malt wine into vinegar, the already weak and unrectified alcoholic liquid is diluted with still more water. And we may cite more cases which prove that concentration is preservative, and dilution with water, to the contrary, is favorable to a change in the chemical constitution of organic substances under consideration. Even the druggist and the housekeeper know that the extracts and preserves must have a certain degree of concentration in order to keep, and that dilution has to be reduced by evaporation, or the addition of plenty of sugar; the most concentrated grape juice produces the best-keeping wines; and, *vice versa*, watery grape juice gives sour wine.

We are satisfied that these laws which govern alcoholic and acetic fermentation do also prevail in the case of putrefactive fermentation, and that a certain dangerous form of the latter does not prevail when the effete organic matter is in a condition of concentration, as is the case in the old style cesspools, but that when an abundance of water is continually added, and the material kept for a long time in closed sewers at a moderate temperature favorable for fermentation in winter as well as in summer, also beyond the powerfully disinfecting influences of sunlight, fresh air, and consequent oxidation and evaporation, we hold that under these conditions a putrefactive fermentation is set up, which fills the stagnant air over the contents of the sewers with germs, which, when escaping with this air, even in small quantities, give rise to the zymotic diseases of which we hear so much in all localities where the modern system of sewage has been introduced.

We have no doubt that the present progress of microscopy will ultimately lead to the detection of the nature of the organic germs which are evolved in this way, and which undoubtedly are the primary cause of the diseases designated under the name of zymotic, and which may take the form of typhus fever, scarlet fever, diphtheria, etc., according to the disposition of the individuals and other circumstances under which they are placed.

Our system of sewage, as now generally adopted, is nothing less than a double waste—a waste of the water provided by the waterworks, where the water is often pumped up at great expense, occasionally causing a water famine, while, what is far worse, it is a waste of a most valuable fertilizing material, which ought to be returned to the soil from which it came in place of being carried off in the rivers to pollute them.

As man is a product of the soil as well as the tree of the forest, nations impoverish themselves when they disregard this agricultural economy. Already, several years ago, the eminent German chemist, Liebig, has raised his voice against this wholesale suicidal system, and pointed out how the downfall of many nations of antiquity may be chiefly traced to the fact that the fertile soil surrounding their large cities became exhausted and barren, and did no more produce enough to make farming profitable. Modern means of easy transportation do to some degree correct such evils, but it is evident that a city which can draw its fresh vegetable garden products from its immediate neighborhood, is at a great advantage over one which has to draw them from a distance, as well in a sanitary as economical point of view, and in order to keep such production up, matters should be so arranged that farmers could consider every neighboring large city as the reliable and inexhaustable supply of the fertilizing material they need.

We can here point to one of the most prosperous little nations in Europe, living in a country having by no means a soil naturally fertile, but only rich in some mineral resources, such as coal, iron, and building stone. We refer to little Belgium. This country not only uses its own fertilizing material of the land under discussion, but even buys it from the easily accessible cities of surrounding nations, such as Western Germany and Northern France and Holland, sending there regularly vessels to be loaded with night soil; this was done already more than fifty years ago.

It is indeed surprising that many nations import fertilizers from foreign countries, such as guano from a distance of thousands of miles, while an equivalent material, continually produced at home in enormous quantities, is not only neglected and wasted, but by a silly devised system of cleanliness is caused to spread contagious diseases through our streets and to pollute the rivers and streams to such a degree as even to kill the fish, as has repeatedly been the case in small rivers near populous cities.

In conclusion, we must confess that we are driven to the opinion that our expensive sewage system is all wrong, as well from a sanitary as an economical point of view; that an improved cesspool system or its equivalent is far superior. But then it must be such a one as will not allow the soil to become polluted; the cesspool should have a water-tight bottom, as carefully laid in hydraulic cement as a cistern, and not like one we found in a house we bought in Philadelphia, where the cesspool had only masonry at the sides, it being intended that the liquid should find its way out by percolation through the bottom, the water closets being provided with the usual water supply, as if intended for a sewer. The result was, that the cesspool was always full or half full of water, especially after rainy weather, and the contents were often soaking through the cellar walls. This was unbearable, and a sewer connection was established as the best remedy under the circumstances. We mention this case as a specimen among hundreds; the house in question was one in a block of twenty houses all alike.

Such a system will, in the course of time, pollute the soil of a city, and it was a similar state of affairs which prevailed at Princeton, as appears from the report of our worthy contemporary, *The Sanitary Engineer*, who investigated and reported the case. The sickness was worst in the newest buildings.

ON THE COLOR RELATIONS OF NICKEL AND COBALT.

By JAMES BOTTOMLEY, D.Sc.

FOR some experiments which I was making in colorimetry I wished to obtain a solution which would absorb all the kinds of light in the same ratio, so that whatever sort of light we started with, after penetration through such a solution, it would remain the same in character, the only variation being a change in intensity. Hence through such solutions white surfaces would appear gray of various shades, verging toward blackness as the length of the column increased. Such a fluid we might call a soluble black.

I am not aware of any single fluid that fulfills the above conditions. It might be said, Why not use ink? But such specimens of ink as I have examined are bluish or violet on copious dilution. Moreover, the color alters with the degree of oxidation; also, it seems to be coloring matter in suspension rather than in solution. I had some hopes of succeeding by mixing solutions of nickel and cobalt salts. On reference to the *Phil. Mag.*, vol. vi., p. 15, I find that the color relations of nickel and cobalt had been studied by Mr. Thomas Bayley with a view to the quantitative determination of these metals, founded upon the complementary character of their colors. He states:

"The fact will have been observed by chemists that solutions of nickel and cobalt salts are so far complementary in color that, when they are mixed together, the resulting liquid, if moderately dilute, is hardly to be distinguished from pure water."

After considering the nature of the absorption spectra of nickel and cobalt salts, he states:

"If the spectra were exactly complementary, on superimposing the nickel spectrum upon the cobalt spectrum, the dark part on the one would cover exactly the light part on the other. This, however, though nearly the case, is not exactly so; . . . this is why the solution obtained by mixing strong solutions of nickel and cobalt is not gray, but reddish brown in color."

Some experiments which I made seemed to confirm the opinion of Mr. Bayley; the nickel solutions contained 0·05 grm. of $NiSO_4$ per c.c., and the cobalt solution contained 0·05 grm. $CoSO_4$ per c.c. A mixture consisting of 50 c.c. of cobalt solution with 100 c.c. of nickel solution contained in a white porcelain basin seemed to be a gray tinted with pink in the shallower parts, and having a tendency to pass into a yellowish tint as the depth increased. I now poured the fluid into a tall glass cylinder covered externally with black cloth except a circular aperture of 8 mm. diameter at the bottom.

When I looked through the column of fluid at a white surface, the color was decided, resembling somewhat the pigment known as yellow ocher. Also, with a less proportion of cobalt to nickel—namely, 20 c.c. of cobalt solution to 50 c.c. of nickel solution—I still obtained a tint in which yellow seemed to predominate. Had I employed solutions so dilute that no color was perceptible in the mixture, this would not strictly imply that the colors were complementary, but that the resulting tint was too feeble to produce the impression of color; and if we filled a long tube with such a dilute solution the color might again become manifest. Moreover, my aim was not to mix two colored solutions so as to obtain a fluid which exercised no perceptible absorption of light, but to obtain a fluid which would exercise a considerable absorption subject to a certain condition.

The following consideration seemed to me to render it hopeless to obtain a soluble black by nickel and cobalt only. A solution of cobalt when dilute is pink, but if we look through a considerable thickness or through a concentrated solution, the pink shows a tendency to pass into scarlet. This shows that, as the quantity of the salt increases, the ratio of the yellow to the red increases. The color of the undissolved salt is brownish red, and the color of the solution seems to approximate toward this as the concentration increases. Hence the color of a solution of cobalt alters not only in intensity but also in kind as the amount of the salt is increased. On the other hand, the green of a solution of nickel varies in intensity, but does not seem to vary in character, at least in any marked manner, as the quantity of the salt increases.

In order that it should be generally complementary in character to cobalt, any inconsistency in the ratio of the red to the yellow of the latter would require a corresponding variation in the ratio of the yellow to the blue in the former, and the tint ought to pass from an emerald green to a bluish green. As this does not seem to be the case, it would follow that if we mixed nickel and cobalt so as to obtain a perfect gray for a column of definite length, a column longer or shorter than this would still retain some color. My experiments seemed to indicate a deficiency of blue in

the mixture, and this I thought might be supplemented by another salt; so I tried the addition of sulphate of copper. After some trials I got a solution containing in 1,000 c.c. 7·275 grms. $NiSO_4$, 4,868 grms. $CoSO_4$, and 11,468 $CuSO_4$; the solutions also contained 30 c.c. of strong sulphuric acid; this I added to guard against any possible formation of subsalts on copious dilution. This solution seemed nearer to what I wanted than a solution of nickel and cobalt only. It did not, however, appear wholly free from color, and possibly a variation of the quantities might have given a better result; also the tint seemed to vary somewhat with the nature and intensity of the incident light. When in the failing light of approaching evening I held the containing bottle against the gray sky I thought that there remained a somewhat pinkish tint, while in the calorimeter, when looking at an external white surface through a column sufficiently long to produce a perceptible absorption, I thought the solution had a bluish tint. When viewed against gaslight it gave a greenish tint. Within the range of colored fluids in chemistry there may be some which if combined would yield a mixture absorbing all colors in the same ratio, so as to be truly a soluble black. The preparation of such a fluid would be an interesting problem in physics. It seems to me that we might also have such fluids which, on spectral analysis, would show not an absorption of all colors in the same ratio, but would be resolved into a violet and yellow, or an orange and blue, or red and green, or some other combination of colors of a complementary character.—*Proceedings of the Manchester Literary and Philosophical Society.—Chemical News.*

EXPLOSIVE MIXTURES OF COAL GAS AND AIR.

By Mr. W. FOSTER, M.A., Etc., Professor of Chemistry at the Middlesex Hospital.

THE first determinations of the velocity of flame in an explosive mixture of gases were made by Professor Bunsen, of Heidelberg. In the case of a mixture of oxygen and hydrogen in the proper proportions for complete chemical combination, the velocity of the transmission of flame through the mass of the mixture was found to be 3f yards per second, while in the case of a mixture of carbonic oxide and oxygen in their proper proportions, the velocity was less than a yard per second. Professor Bunsen further found that when such explosive mixtures were diluted with a gas which did not take any part in the combustion, or when there was an excess of either gas in the case of each of the simple mixtures just referred to, the velocity of propagation of the flame was diminished. The method of experiment adopted in these investigations was to force the explosive mixture from a reservoir through a long narrow tube. The velocity of the gas stream was observed when it was just sufficient to maintain the position of the flame constant with reference to a point in the side of tube. More recently Professor Mallard, of the French School of Mines, has extended this inquiry. He has made a number of experiments in a manner similar to that of Professor Bunsen, using mixtures of marsh gas (fire-damp) and air, and coal gas and air, in different proportions. We have already seen that 2 volumes of marsh gas require 4 of oxygen for complete combustion, therefore 1 volume requires 10 of atmospheric air to effect the same purpose. It is an interesting fact that the velocity of transmission of flame in such a mixture is less than the maximum possible. It was found that a mixture of 1 volume of marsh gas and 8¼ of air gave the highest velocity, and this was a little more than half a yard per second. With mixtures of coal gas and air the velocity of transmission of flame is greater than with mixtures of marsh gas and air. This result would be anticipated on a consideration of the composition of coal gas and the results obtained by Professor Bunsen, which have just been referred to. Common coal gas contains about half its volume of hydrogen, and therefore its chief component, when mixed with air, furnishes a mixture the rapidity of inflammation of which is very high—in fact, much higher than that of a mixture produced by any one of the other components of coal gas and air. But in all the cases of explosive mixtures now under notice, there is a relatively large quantity of inert gas present —namely nitrogen—which diminishes the rate of inflammation, as shown by Professor Bunsen. In M. Mallard's experiments on mixtures of coal gas and air, he found that with the particular sample of coal gas employed, the maximum rapidity of inflammation occurred with a mixture consisting of 1 volume of coal gas and 5 of air. This gave a velocity of rather more than a yard per second. In a published letter by Dr. Thorpe, of Leeds, on the theory of the Bunsen lamp, a summary of M. Mallard's observations is given. I have taken the liberty of expressing the meters of the original table as yards:

Volumes of Air mixed with One Volume of Coal Gas (Composition not given).	Rapidity of Inflamation in Yards per Second.
6¼	0·308
6	0·672
5½	0·893
5¼	1·073
5	1·100
4¾	1·019
4½	0·806
3⅔	0·105

It is obvious from a perusal of this table that the velocity of propagation of flame in explosive mixtures of coal gas and air may vary very considerably. When the mixture consists of 1 of coal gas to 7 of air, we may safely consider the velocity as being not greater than a foot per second; whereas if the mixture consists of 1 of gas to 5 of air, there would be a velocity of not less than 3 feet per second.

Let us now consider the bearing of these principles on every-day practice. Suppose an explosive mixture (1 of coal gas to 7 of air) to be placed in a suitable vessel, and in communication with the external atmosphere by means of a cylindrical pipe, several feet (say 6) in length, and further suppose that the internal diameter of the pipe is half an inch. If the pressure of the explosive mixture be the same as that of the atmosphere, but little of the former will escape into the external atmosphere. That portion which does escape is due, first, to the fact that the explosive mixture is lighter than atmospheric air; and, secondly, to the superior diffusive power of the explosive mixture. At the most there would be but a slight smell of gas if an observer were to place his nose close to the extremity of the open pipe. On the application of a flame to the extremity of the open pipe, the mixture would ignite, and the flame would traverse the length of the pipe quietly with a velocity of about three feet per second. In two seconds from the application of flame to the open pipe the explosive mixture in the containing vessel itself would be ignited, and an explosion would almost immediately follow, the character and extent of which would be modified by the shape of the containing vessel and the total volume of the explosive mixture.

Now let us suppose that the explosive mixture in the vessel has a pressure which is greater than that of the atmosphere, and that this pressure is maintained constant by artificial means. The escaping mixture can be ignited as before; but whether it will give rise to an explosion in the containing vessel, or not, depends on the velocity of the gas stream along the ½ inch pipe. If the velocity be anything greater than 3 feet per second, the explosive mixture in the vessel will not be ignited; but if the velocity be anything less than 3 feet per second, the flame will pass down the pipe with a velocity which is the difference between the two velocities—namely, that of the transmission of flame by the explosive mixture, and that of the gas stream along the pipe. If the velocity of transmission of flame be 3 feet per second, and the velocity of the explosive mixture along the pipe and at its external orifice to be 2 feet per second, then the velocity of the flame with reference to the sides of the cylindrical pipe will be 1 foot per second, and, consequently, it will require six seconds for the transmission of flame from the external orifice of the pipe to the mass of explosive mixture in the containing vessel. We can, therefore, express the behavior of explosive mixtures in a general way by saying *that so long as the velocity of the explosive mixture at the point or points where it escapes into the atmosphere is greater than the velocity of transmission of flame through the explosive mixture, there will not be an explosion in the containing vessel on the application of flame to the above point or points.*

It will be well if we now consider what is the velocity of a stream of gas in our ordinary arrangements for burning common gas. It is usual to consume it at the rate of 5 cubic feet per hour per burner. Some burners within my reach are attached to a metal pipe, the internal diameter of which is 2·8ths of an inch. Using the same factors as in our former calculations, the length of such pipe necessary to hold 5 cubic feet of gas is 184,000 inches, or 5,111 yards. Dividing this number by 3,600 (the number of seconds in one hour), we obtain 51 inches, or 4·2 feet, as the velocity of the gas stream per second in the pipe, when gas is consumed at the ordinary rate. But the orifice of the burner itself is much less than 2-8ths of an inch in diameter, and therefore the velocity of the escaping gas at this point must be something considerably greater even than 4·2 feet per second. It follows, therefore, that if in our ordinary domestic arrangements there should be an accumulation of an explosive mixture of gas and air through a defect in the pipes or other unforeseen circumstance, there is no reasonable chance of the slightest danger arising from the application of flame to the explosive mixture escaping from the burner at the ordinary pressure. Were it otherwise accidents might possibly occur.

We have now discussed at some length the conditions necessary to be maintained in order to prevent the ignition of explosive mixtures of gas and air in containing vessels when they are at the atmospheric pressure, as well as when they are at higher pressures. We have just seen that the possibility of danger chiefly consists in the pressure being so slight as to cause the stream of the explosive mixture to have less than a certain velocity. If, under these circumstances, the pipe be wide enough to allow combustion of the explosive mixture to keep up its own temperature of ignition, the explosive mixture in the containing vessel must eventually be ignited. Now, in ordinary practice the pressure of coal gas (we will not go so far as to say explosive mixture) may be determined roughly by the application of a light, and there is no doubt that this practice is often adopted. In the case of vessels which *may* contain mixtures of gas and air, the application of flame in the ordinary way is most dangerous, specially if the pressure inside the vessel be nearly the same as that of the atmosphere. In the absence of that which is to be determined by the test—namely, superior pressure, there is every probability of an explosion following the application of the test itself. In order that a flame may be applied as a test of the combustibility or otherwise of the gaseous mixture, or to roughly determine its pressure, it is necessary that the pipe or jet should be specially constructed. By diminishing the diameter of the pipe, so as to make it very small, we prevent the possibility of flame passing into the interior of the containing vessel, and in order to compensate for the small quantity of gas or explosive mixture passing outward through such small pipe, it is necessary to arrange a number of these in the form of a bundle. A compound tube, made up of a number of very narrow tubes, would then permit of the escape of sufficient gas, or of the explosive mixture, at a very low pressure, and flame could then be applied to the external orifice to indicate the character of the escaping gas, without any danger of ignition of an explosive mixture in the containing vessel. Such an arrangement has long been in use for burning explosive mixtures of oxygen and hydrogen. A simpler arrangement, and one which can be easily constructed, consists of a piece of metal tube, upward of an inch in diameter, and several inches in length, packed with carefully cut disks of fine wire gauze. The disks must fit the internal parts of the pipe accurately, otherwise their function will be imperfect. In either case flame cannot pass backward under any circumstances so long as the bundle of metallic pipes or the cylinder packed with disks of wire gauze is kept at the atmospheric temperature.

We have now to consider the conditions favorable to the production of mixtures of coal gas and air, and the laws which regulate their formation. Taking common air as the standard substance, the specific gravity of common gas ranges between 0·4 and 0·5. We may, therefore, regard it as possessing half the density of atmospheric air. It has weight, as is implied by its specific gravity, and is therefore subject to the laws of gravitation, like all material substances. When it escapes in atmospheric air, it tends to ascend and this arises from two circumstances—first, the coal gas is the lighter of the two substances; and, secondly, both coal gas and air are examples of a fluid body. The particles of a fluid are readily susceptible of change with reference to each other and to those of a second fluid when there are differences of specific gravity, or when pressure is applied, and the like. When a jet of unignited coal gas escapes in an ordinary way, the lighter gas particles ascend, in consequence of their freedom to move, not only with reference to themselves, but also with reference to those of atmospheric air. So far, therefore, as the laws of gravitation affect the gas and air particles, the former ascend to the upper portions of the apartment, displacing the heavier particles of air; and were there no other influence besides the laws of gravitation in operation, the gas particles would collect in the upper portion of the apartment unmixed with air. As a matter of common observation, we know that this separation of gas and air into distinct layers does not occur; and, further, that when the gas and air particles are thoroughly mixed, either by natural processes or artificially, there is no separation of gas and air into two layers on allowing the mixture to remain at rest. The lighter gas particles do slowly mix with the heavier air particles in opposition to the law of gravitation, and in the course of time the former will be equally dispersed through the air of the apartment, supposing there to be no chance of escape for either gas or air. The lighter gas diffuses itself through the heavier air in obedience to certain laws.—*Journal of Gas Lighting.*

NEW ANILINE COLORS.

By K. ENGAN.

AMONG the latest novelties in the manufacture of aniline colors particular notice is due to two products of the Baden Aniline Company, magenta S and light green S. Both these dyes fill up gaps in the series of the aniline colors which formerly made themselves felt very plainly and very disagreeably.

Magenta S gives the same shades which have hitherto been obtained with ordinary magenta. The difference lies here that the latter was used (for wool dyeing) in a boiling water without the aid of any mordant, while the new color is used at a boil with the addition of a little sulphuric acid, or of prepared tartar, or of sulphate of soda along with sulphuric acid. Hence arise the following advantages, which hold good in practice. The colors dyed with magenta S bear fulling and soaping perfectly, but cannot resist soda. Hence all the trouble caused by woolens dyed with ordinary magenta bleeding and soiling whites, or other colors which are fulled or soaped simultaneously, is removed. Secondly, magenta S can be used for dyeing acid-fast shades. As the substance is readily and entirely soluble in water, it may be put into the dye beck in the solid state, dispensing with the trouble of dissolving the color separately, and filtering.

Light green S, seen by artificial light, gives the same remarkably brilliant shade as methyl-green, malachite green, etc. Its use offers very important advantages, because it is taken up by the woolen fiber under much simpler conditions than its rivals. The process is very simple. It is dyed in a boiling beck, to which have been added per 2 lb. 3 oz. wool, 2 oz. prepared tartar, or a corresponding quantity of sulphate of soda and sulphuric acid. The production of night green formerly was possible only in wooden vessels, all metals except zinc being carefully avoided, and it required two baths, the prepare and the dye beck. Light green S can be dyed in a single operation, and the beck may be of any material. It can also be used along with extract of indigo or with fustic to give various shades of green, which resist fulling and scaping, and show a distinct green by artificial light.—*Deutsche Industrie Zeitung.*

PRINTING ANILINE BLACK WITH VANADIUM.

THE color thus got up is suitable for all styles; it bears perfectly well to be steamed after aging, *e. g.*, where it is associated with alizarine steam red. In cases where aniline black is printed along with mordants which are afterwards to be dyed up with alizarine or garancine, the black with vanadium has a decided advantage over that with sulphuret of copper, as the former does not injure the mordants. Further, the colors with vanadium attack the doctors and the cylinders less than do those with sulphuret of copper. These latter have a decided disposition to become oxidized on exposure to the air, forming soluble sulphate of copper, and in that state they are no longer without action on the steel doctors. For the same reason the vanadium colors can be kept better, providing that the proportions previously given are not exceeded. If we consider the regularity with which increased doses of vanadium accelerate the oxidation of the aniline, we find an easy means of regulating the time of the oxidation, *i.e.*, the time of exposure in the aging room.

We must not forget here to mention an improvement which will doubtless lead to a great extension in the use of aniline black in printing. We mean the discovery of a kind of aniline oil which yields an ungreenable aniline black.

We know the imperfection of the ordinary means proposed to hinder aniline blacks from greening. Thus aniline black, after fixation, is rarely taken through baths of chromate of potash, copperas, and sulphuric acid. This procedure, moreover, is only applicable in a limited set of cases. The black superoxidized in this manner certainly does not turn green, but it has lost its beauty and takes a brown, earthy tone. The whites of the pieces suffer likewise from the effects of the chrome, and are not easily got clean. The discovery of a special aniline oil which produces a black at the outset and upon which acids and reducing agents have little or no influence will therefore open a new epoch in the history of aniline black.

The conversion of this new product into black proceeds, however, more slowly than the oxidation of the common aniline, and requires, therefore, a more energetic oxidizing agent. Hence, for this kind of black vanadium is always required in place of suiphuret of copper. The proportion of the vanadium is also larger than for the common black. The composition of the color for an ungreenable aniline black is as follows:

Water	5,500
White starch	1,250
Dark calcined starch	420
Boil, and when cooled down to 122° Fahr., add—	
New aniline oil	800
Muriatic acid at 32° Tw.	800
When completely cold add—	
Chlorate of soda	420
Boiling water	500
Just before using add—	
Solution of vanadium (as mentioned elsewhere in our present number)	200

Age for two days, take through bichromate of potash 75 grains to 1¼ pints of water at 158° Fahr., wash, and soap.

It is better, instead of using the quantities of aniline and muriatic here specified, to neutralize the aniline exactly with the necessary quantity of muriatic acid. In so doing, it is well to make use of the indicator pointed out by Witz, namely, methyl violet. To the 800 parts of aniline oil muriatic acid is added till a few drops of the liquid, added to a very dilute solution of methyl violet in water, turn its color to a greenish blue.

It must not be forgotten that the development of this black requires a higher degree of moisture than the common aniline black. Hence it is useful to add to the color a certain proportion of sal ammoniac—a salt which, on account of its hygroscopic character, plays an important part.

Lastly, a portion of common aniline may be substituted for some of the new aniline oil. This effects, in the first

place, a certain saving, as common aniline is the cheaper of the two; and, secondly, the color is more readily developed, while the resulting black still retains its ungreenable character, unless, indeed, too much common aniline has been used.—*Chemical Review.*

ANILINE BLACK DYEING BY MEANS OF VANADIUM.

ANTONY GUYARD was the first to propose vanadium for dyeing an aniline black on fibers of any origin. The beck for dyeing cotton yarns is made up of muriate of aniline, chlorate of potash, and a small trace of vanadium. Thus for dyeing 100 lb. of yarn there are required 5 lb. muriate of aniline, 2 lb. chlorate of potash, and about 9 grains of the vanadiate of ammonia. Witz considers that 1-8,000th part of the weight of the muriate of aniline is the outside quantity that should be used.

The development of the color is relatively the more rapid the larger the quantity of vanadium present, and in this manner the duration of the dyeing process can be regulated at will.

For dyeing silk Guyard recommends the addition of ¾ to 1 oz. gum arabic to the dye bath. In this manner satisfactory results are produced; the silk loses nothing of its brightness, and the dyeing can be completed in one operation.

Wool must be carefully freed from fatty matter, and the dye beck must contain two to three times more muriate of aniline than that required for cotton.

The fixation of the black is finally effected by a passage through bichromate of potash.

It must be remembered that aniline black is of much less value for silk and wool dyeing than for cotton and linen.

Hommey has published some interesting particulars on the use of vanadium in wool dyeing. If this new agent is employed the previous treatment of the tissue with bichromate of potash, blue vitriol, and acid is unnecessary. It is merely required to dye for twenty to thirty minutes in a beck of muriate of aniline, chlorate of potash, and vanadiate of ammonia, then run through a padding machine, and age in a warm room. The next day the dark green which has been formed is converted into a black by being taken through bichromate of potash. A good result is obtained with the following proportions:

10,000	parts	water,
800	"	muriate of aniline,
400	"	chlorate of potash,
50	"	muriatic acid,
1	"	vanadiate of ammonia.

For a regular and perfect fixation of the color the author proposes the following routine: The goods are first saturated with the solution of muriate of aniline and chlorate of potash in the padding machine so as to force the solution right into the fiber. The vanadiate of ammonia is then dissolved and added to the bath, and the same process is repeated. This process is also very suitable for mixed goods, cotton and woolen or cotton and silk. As the black is more readily developed on the cotton shot effects or patterns may be produced on mixed goods. Thus, if we dye in a dilute beck and take afterwards through chromate of potash, the cotton takes a deep violet black, and the wool an olive brownish yellow, which is much admired.

We may mention here certain other reactions and transformations of which the vanadium compounds are capable, and which will doubtless before long be introduced into practice.

Extract of logwood, if treated with chlorate of potash and salts of vanadium, is converted into a yellow coloring matter, which dyes silk a splendid golden yellow.

Under the same conditions the muriate of (solid) toluidine yields a new coloring matter which imparts to silk a rich bronze color with a coppery luster.

If in dyeing the ordinary chrome logwood blacks a vanadiate of potash is used instead of a chromate, exceedingly fine black shades are obtained.

Catechu browns have been produced with a beck of catechu and chloride of vanadium or vanadiate of ammonia.

It is very probable that in the ordinary oxidized catechu colors vanadium might be advantageously substituted for the salts of iron and copper generally used as oxidizing agents. The question of price is of course here the turning point. It is probable, from analogy, that the far greater activity of vanadium might more than compensate for the greater cost per pound.

Vanadium will also probably be of use in the preparation of the naphthylamin colors. This base has in its behavior and reactions a considerable resemblance to aniline, and when oxidized in a corresponding manner it has already yielded a series of grays, browns, and modes.

Another reaction, not concerned with the fixation of colors, has been pointed out by Schmid and Baldensperger. These chemists have succeeded in producing magenta with aniline, nitrobenzol, and small quantities of vanadium. The last substance plays here the same part as in the formation of aniline black. It transfers the oxygen of the nitrobenzol to the aniline, just as in aniline blacks it transfers the oxygen of the chlorate of potash to the aniline.

An interesting fact has been recently observed by Professor Roscoe. If finely powdered vanadic acid is dissolved in boiling concentrated sulphuric acid, and the dark red liquid thus obtained diluted with fifty times its weight of water, and digested with metallic zinc, the coloration runs through all shades from blue or green to a violet. The vanadium is then present in solution in its lowest form of oxidation, and this compound absorbs oxygen with such energy that it decolorizes indigo and other vegetable colors as rapidly as chlorine. It is the most energetic reducing agent known, and as such will, doubtless, admit of applications in the tinctorial arts.

APPLICATION OF VANADIUM COMPOUNDS IN THE INK MANUFACTURE.

The solutions of the vanadiates of potash, soda, and ammonia, especially the acid salts, yield, if mixed with decoction of galls, a perfectly black liquid, which may be used as ink. Berzelius said of this ink, long ago, that it was the best ink that could be used. It has this advantage over the ordinary black inks (iron inks) that it resists reagents much better. It is not attacked by alkalies unless so concentrated that they destroy the paper. Acids turn it to a brownish green, but do not destroy it. It is also blacker and flows better than the iron inks, being a true solution, and not, like common ink, merely a finely-divided precipitate suspended by means of gum water. Like the aniline inks, it does not require gum or any similar body, and consequently it never clogs or forms a coating on the pen as do the gummed inks. Even after a long time no sediment or deposit appears in vanadium ink. Ten years ago Wagner called anew public attention to vanadium inks, and latterly Boettger has given a receipt for an ink of tannin and vanadiate of ammonia. This ink seems to fulfill all the requirements of a safety ink, and if the reduced price is considered, it is not likely to come in much dearer than ordinary inks of good quality.

According to the experiments of Dr. B. W. Gerland, metavanadic acid may be used in the preparation of a substitute for genuine gold bronze. If a solution of sulphate of copper and sal ammoniac is mixed with vanadiate of ammonia and cautiously heated, there is obtained a compound of a splendid gold color, which is deposited from the liquid in the form of gold-colored spangles. These admit of being readily ground up with gum and varnishes, cover well do not change on exposure to the air, and are in every respect equal to genuine gold bronze.

Vanadium yields also a series of very fine colors, especially adapted for painting on porcelain.—*Chemical Review.*

INCOMBUSTIBLE TISSUES, ESPECIALLY CURTAINS, BALL DRESSES, ETC.

THE following matter may probably be of advantage to garment dyers who are occasionally called on to give a fireproof finish to dresses.

Among the means recommended for this purpose we may, in the first place, mention one of exceeding simplicity, applicable to muslins and all dresses which are starched after washing. It is merely necessary to mix the starch with sal ammoniac and plaster of Paris. The goods thus dressed may certainly be set on fire by the flame of a match, but the flame does not extend. The inventor of this first process afterward recommended

Borax	12 parts,
Epsom salts	9 "

dissolved in eighty parts of warm water. The tissues to be prepared are dipped in the solution till thoroughly saturated. They are then pressed, wrapped in a cloth, wrung again, laid between cloths, and passed through a mangle, after which the articles are ironed while still damp. The necessary quantity of starch can be stirred in the saline solution.

Vogt dissolves

Sublimed sal ammoniac	2 parts,
Sulphate of zinc	1 part,

in fifteen to twenty parts of water. The starch or other ingredients required for stiffening or finishing are added to the solution. The dresses, etc., are steeped in the mixture till thoroughly saturated, pressed well out, and dried. According to Siebrath a good result may be got by steeping the dresses in a solution containing five per cent. alum and five per cent. phosphate of ammonia. Tissues so treated are said not to burn, even if previously rubbed with gunpowder. The powder deflagrated, but left the tissue unburnt. Hottin proceeds in a very similar manner. He takes a solution of acid phosphate of lime, mixed with ammonia in excess. After decolorizing it with animal charcoal [? Where is the color to come from?], he adds five per cent. gelatinous silica and evaporates to dryness. The dresses to be made fireproof are laid in a thirty per cent. solution of this mixture, which he calls "Hottine."

[If this mixture has once been evaporated to dryness, we do not see how it can be all brought into solution again without the aid of an acid. Acid phosphate of lime, if mixed with ammonia, will be precipitated as insoluble tribasic phosphate of lime, while the excess of the phosphoric acid will combine with the ammonia. So that the process is, in reality, merely a method of making phosphate of ammonia.]

Among other agents proposed for the same purpose are soluble glass, tungstate of soda, ammonia, alum, and hyposulphite of soda. According to Versmann and Oppenheim, phosphate of ammonia is mixed with half its weight sal ammoniac, and a twenty per cent. solution of the mixture is used. Tissues which are to be afterward ironed are afterward treated with a twenty per cent. solution of the tungstate of soda.

The "phœnix essence" of M. Pereles consists of a mixed solution of tungstate, silicate, and phosphate of soda.

Nicoll proposed a bath of

Alum	6 parts.
Borax	2 "
Tungstate of soda	1 part.
Dextrine dissolved in soap lye	1 "

The dextrine is said to cause the salts to adhere better to the fiber.

More recently two receipts have been given in the *Berichte der Deutsch. Chem. Gesellschaft* (XII., p. 2391).

The first is:

Sulphate of ammonia	8 parts.
Carbonate of ammonia	2½ "
Boracic acid	2 "
Borax	1¾ "
Starch	2 "
Water	100 "

The dresses or other tissues are taken through this mixture boiling.

The second receipt is:

Boracic acid	5 parts.
Sal ammoniac	15 "
Potash feldspar	5 "
Gelatine	1½ "
Starch paste	50 "
Water	100 "

This mixture is applied with a brush.—*Industrie-blaetter.*—*Chemical Review.*

ALIZARIN BLUE.

By C. GRAEBE.

THE author ascribes to this compound the formula $C_{17}H_{11}NO_4$. Its formation from nitro-alazarin and glycerin depends on the simultaneous elimination of water and oxygen. The latter does not appear in the free state, and is doubtless concerned in the formation of the abundant brown secondary products. Alazarin blue is easily attacked by oxidizing agents, such as nitric acid and permanganates, the chief product being phthalic acid. With reducing agents in an alkaline solution it yields a reduction-vat, analogous to the indigo-vat, from which the coloring matter is re-precipitated with a blue color on exposure to air. The author considers alizarin blue as an anthracen derivative, in which the hydrogen atoms of one benzol nucleus are not replaced by other elements.

CONSTANCY OF CARBONIC ACID IN THE AIR.

By T. SCHLOESING.

THE author considers that the sea exercises a regulating action upon the proportion of carbonic acid present in the atmosphere as well as upon that of watery vapor and ammonia. It is admitted that the sea, if extended in a vertical layer over the whole surface of the globe, would have a depth of 1,000 meters. The quantity of carbonic acid contained in a vertical prism of this stratum, having a base of one square meter, is 98·3 kilos. These 98·3 kilos forming bicarbonates, half the quantity, 49 kilos, is retained by the bases. Supposing that the atmosphere has a uniform composition, and contains in volume two ten-thousandths of carbonic acid, a vertical prism of this atmosphere with a base of one square meter would contain only 4·7 kilos of carbonic acid. The sea thus holds in reserve a quantity of carbonic acid available for exchange with the air ten times greater than the total quantity contained in the latter, and, *a fortiori*, very much greater than the variations of such quantity.

ON THE ANALYSIS OF SOAPS.

By JUL. LOEWE.

FOR the determination of moisture the author takes from eight to ten grammes shaved very finely, and dries them, first, at 60° to 70°; afterward, at 100° to 105°. If it is supposed that the soap contains caustic alkali, the process must be conducted in an atmosphere free from carbonic acid. The free alkali may also be determined before the process of drying by exposing a portion of soap, shaved very fine and weighed, upon a watch glass in a cylinder filled with dry carbonic acid and closed, the proportion of caustic alkali being calculated from the increase of weight. The exposure must not last too long, in order to prevent the formation of bicarbonate.

To determine free unsaponified fat, the portion of dried soap is thrown into a rather high beaker capable of being well covered, and extracted with benzol or petroleum with the aid of heat, according to the method of Perutz, and decanting when clear into a small tared flask. If the decantation is difficult it is passed through a weighted filter, which is afterwards used for the alcoholic solution of the soap. After two or three extractions the filtrates are collected and distilled, the residue dried at 108° in a chloride of sodium bath, and the increase of weight of the flask is noted, which shows the proportion of the non-saponified fat.

The residue freed from such fat is covered with about eight to ten parts of alcohol at 90° per cent., and heated from 40° to 50° in the water bath. Caustic alkali, and that in combination with fatty acids, along with glycerin, are readily dissolved, whilst soda (carbonate), farina, and mineral impurities remain undissolved, and after washing with hot alcohol and drying at 100° may be weighed. In the better class of soaps the residue does not exceed 1 to 1½ per cent.

A moderate stream of well washed carbonic acid is then allowed to play upon the surface of the warm alcoholic filtrate. Caustic alkali, if present, is deposited as alkaline carbonate. The beaker is covered, allowed to stand till clear, heated in the water bath, the contents filtered, and the filter is washed with warm alcohol. In the aqueous solution of the residue the carbonate of soda may be determined volumetrically.

The second alcoholic filtrate, thus freed from soda, is mixed with sulphuric acid diluted with alcohol as long as a turbidity is produced. When clear the sulphate of soda deposited is filtered off, collected upon a weighed filter, washed with alcohol, dried at 110°, and weighed. The weight shows the alkali which was in combination with the fatty acids.

The filtrate is acidulated with sulphuric acid, mixed with water, and freed from alcohol by evaporation in a platinum capsule. When cold, the acid aqueous extract which may contain glycerin, is separated from the congealed fatty acids by filtration. These acids, as well as the glycerin, may be determined by known processes, the latter after the accompanying sulphuric acid has been saturated with barium carbonate.

The residue, insoluble in alcohol after being weighed, is washed with cold water till the filtrate makes up exactly 60 c.c. The water is then driven out of the filter by means of alcohol, and the residue is dried at 100°.

After being weighed the residue is submitted to microscopic examination in order to detect starch. Mineral impurities are sought for by ordinary analytical methods.—*Zeitschrift für Analytische Chemie.*

TOBACCO SMOKING EXPERIMENTS.

THE discovery, some years ago, by M. Gréhant, that carbonic oxide is one of the products of the combustion of tobacco, has led to the suggestion that the deleterious effects of tobacco smoking are due to this substance. The suggestion seems improbable enough when we consider what powerful poisons are liberated at the same time, but the theory has seemed to M. Gustave Le Bon worthy of a careful experimental investigation, the facts of which are of some interest. The quantity of carbonic oxide formed was found to amount to about 800 cubic centimeters for each ten grammes of tobacco burned. One per cent. of carbonic oxide in the air breathed will cause death in twenty minutes, and its action is effected, as Claude Bernard showed, by combining with the hæmoglobin. What dose of carbonic oxide, however, without being fatal, will cause dangerous accidents? M. Gréhant formerly killed dogs by compelling them to breathe air which had passed through a pipe containing some grammes of tobacco in combustion, and ascertained by spectroscopic examination the quantity of carbonic acid in the blood.

These observations, repeated by M. Le Bon, yielded the same results as M. Gréhant had obtained. The air, passing through four grammes of tobacco in combustion, caused death in a quarter of an hour; clots were found in the heart, and the blood contained traces of carbonic oxide. Evidently, however, such experiments are of little value, because the air breathed is deprived of its oxygen, and the proportion of nicotin, etc., is so great that the effects cannot reasonably be ascribed to the carbonic acid.

Some experiments were then made by first removing the nicotin from tobacco by the action of boiling ether and ammonia, many times repeated, and then adding to the air which passes through the burning tobacco a sufficient quantity of oxygen to replace that lost in combustion. Nevertheless, in the experiment thus performed, in fourteen minutes the dog was dead, and the spectroscopic examination of the blood showed the presence of carbonic oxide. This result was to be anticipated, for the amount of carbonic oxide

produced by the combustion of the tobacco employed amounted to a fatal proportion of the air respired. But this result is scarcely applicable to the conditions met with in ordinary tobacco smoking.

To ascertain the effect of the carbonic oxide in the latter, it was necessary first to determine the minimum proportion which is deleterious, and then the quantity actually present in a smoker's most limited atmosphere. On the former point physiological researches give little information. To decide it, M. Le Bon shut himself in one of the extremely small kitchens met with in some of the Paris lodging houses, and lighted two stoves (we presume charcoal). In this room, in spite of a chimney, it was ordinarily necessary, for safety, to have the door open. With the closed door, he remained in it until violent headache and nausea became unbearable. Then, before opening the door, he filled with air, by means of bellows, an India-rubber ball holding twenty-five liters. This was not accomplished without difficulty, for his condition had become most unpleasant. Analysis showed that the air contained only one part of carbonic oxide for 3,000 parts of air. In order to produce this proportion of carbonic oxide, it would be necessary to burn 4 grammes of tobacco per cubic meter of air. In a small room—say one of a capacity of 30 cubic meters—it would be necessary to burn 125 grammes of tobacco to produce this quantity of carbonic oxide—an amount of tobacco which would be represented by 50 pipes, 25 cigars, and 250 average cigarettes. The renewal of the air by the door and windows, even if these were closed, would render the amount of tobacco needed much larger; but without considering this, it is evident that the quantity of tobacco could not be burned by the small number of persons who could be accommodated in such a room.

In a compartment of a railway carriage, however, or in a closed cab, a number of smokers might be confined in a much smaller atmosphere. The renewal of the air by the imperfectly-fitting doors and windows would be, however, much greater than in the other case. The effect could only be determined by an actual experiment. Accordingly, M. Le Bon and a friend entered a single-seated cab, which, when their own bulk was deducted, contained about thirty cubic feet of air. The windows of the cab were closed, and for three-quarters of an hour M. Le Bon and his friend drove about, and smoked during the time seven grammes and a half (a quarter of an ounce) of tobacco. The temperature of the interior of the cab was 55° F. at the commencement of the experiment and 71° F. at the end. As some discomfort was experienced, the observation was stopped, an India-rubber bag, holding twenty-five liters, being filled with the air. According to the quantity of tobacco burned, the air should have contained 500 cubic centimeters of carbonic oxide in each cubic meter of air; the quantity was found on analysis, however, to amount to scarcely 100 cubic centimeters—too small a quantity to produce serious inconvenience. It is thus evident that in a carriage, in spite of closed windows, there is such an extensive change of air that the greater part of the carbonic oxide escapes. It is also certain that, even if it did not escape, long before it reached a deleterious amount the effects of the other poisons, nicotin, etc., produced by tobacco smoking, would be much more obtrusive.—*Lancet.*

THE MANUFACTURE OF ALUMINUM, SODIUM, AND SIMILAR METALS.

A PATENT has been obtained by Mr. W. P. Thompson, of Tranmere, for a novel process of manufacture of aluminum, sodium, and similar metals, which, if successful, would very greatly reduce the present high price of these metals. Liquid iron, either alone or in conjunction with hydrogen or carbon, is to be the reducing agent, and the operation is to be conducted in an apparatus similar to the well-known Bessemer converter. This apparatus is made up of two characters. After the iron has been fused in the one it is transferred into the second by turning the converter. Through a tube opening into this second chamber, hydrogen or carbureted hydrogen is allowed to enter, and through another one chloride or fluoride of aluminum in a state of fusion or as gas. Hydrogen and ferric chloride escape, and in the converter remains iron alloyed with aluminum and carbon. This mixture is then again transferred to No. 1 chamber, where the carbon is to be burnt by a current of air. After retransferring to No. 2 the process of reduction is to be continued until the iron is almost wholly consumed, when hydrogen alone is to be used as reducing agent. Thus an iron-aluminum alloy results.

For the preparation of sodium, hydrogen is not requisite. Iron, mixed with much carbon, is to be heated with caustic soda in the converter, and the sodium, said to be formed under these circumstances, is simply distilled off. When all carbon is consumed the iron may be worked into Bessemer steel, or may be again re-carbonized.

Iron and potassium not forming an alloy, the method is not well applicable for the preparation of potassium.

For the manufacture of pure aluminum, sodium is to be preferred in the manner described, and then in the chamber containing the metal, chloride or fluoride of aluminum is to be allowed to enter, air being excluded. The chamber is provided with stirring gear, and is lined with alumina, or a mixture of lime, magnesia, and alumina.

The inventor will likewise apply his process to the preparation of magnesium, calcium, strontium, and barium.

THE SOLUTION OF PLATINUM IN SULPHURIC ACID.

By M. SCHEURER-KESTNER.

THE author concludes from his experiments that absolutely pure sulphuric acid does not attack platinum, and that by making use of ammonium sulphate as recommended by Pelouze we may almost completely avoid injury to platinum vessels. Sulphuric acid containing traces of nitrous acid dissolves platinum, and the activity of this process increases with the concentration of the process. The acid from the lead chambers, even when containing an excess of sulphurous acid, attacks platinum, the nitrous acid resisting the action of the sulphurous acid, and being in a state of stable combination. Hence the corrosion of platinum is always due to the presence of nitrogenous compounds in sulphuric acid. One part in 10,000 suffices to dissolve a proportion of platinum such as is never observed industrially. To ascertain whether an acid is sufficiently free from nitrogenous compounds the most sensitive reactions are necessary. An acid in which ferrous sulphate scarcely reveals visible traces of nitrogen compounds is colored blue by diphenylamine. It contains both sulphurous and nitrous acids, and it attacks platinum. During its concentration the quantity of nitrous acid scarcely diminishes, while the sulphurous acid is completely expelled.

YTTERBIUM.

By L. F. NILSON.

As the mean of seven determinations the author gives the atomic weight of ytterbium as 17·301. Ytterbium, Yb_2O_3, is a white infusible powder, of sp. gr. 9·175. It is insoluble in water, but dissolves readily in acids, even if dilute, with the aid of heat. It is not readily attacked in the cold even by concentrated acids. The solutions are colorless, and do not present any absorption ray. The earth and its salts do not impart any coloration to flame. The anhydrous sulphate is an opaque mass which does not lose all its sulphuric acid below a white heat. The aqueous sulphate forms large brilliant prisms, permanent in the air, but which lose their water at 100°.

RUPTURE OF THE MEMBRANA TYMPANI.

From a Clinical Lecture. By CORNELIUS R. AGNEW, M.D., Clinical Professor of Diseases of the Eye and Ear, in the College of Physicians and Surgeons, New York.

OUR first patient is Mr. Lynch, twenty-four years of age, who, three weeks ago, while "scuffling with a friend," received a "slight" blow over the right ear with the palm of the hand. He felt at the time a ringing sensation in the head, and could hear very little with that ear. He had been deaf in the left ear nearly his whole lifetime, and he says the deafness was the result of catarrhal fever with whooping-cough. His right ear, during the three or four days that followed the blow overlit, grew worse; hearing then improved a little, but since that time it has remained about the same, getting no better. After the accident he syringed his ear with warm water, which made it feel worse.

This watch which I hold should be heard to tick at a distance of forty-eight inches from the ear—that is, if the ear be in a normal condition. In making this test, it is better to begin at a distance, and bring the watch gradually nearer the head. It is also proper to have the eyes closed, so that you may concentrate the test upon this one sense. The senses are so related, the mentality of the senses is so complex, one sense aiding the other, that it is proper to shut off the sight. This is particularly true in the case of children. They imagine you want a certain answer, they see the watch and associate it with a certain ticking sound, and give you an affirmative answer, whether they hear it or not. They will do this after having seen the watch, even if you place it beneath your clothing, so that it cannot be heard at all. What is true of children is true, with some allowance, of older persons. The ticking of a watch is heard by our patient at a distance of six inches from the head, while the distance at which it should be heard is forty-eight inches. So, in recording the hearing distance of the right ear of this patient, we would write, H. D. R. $\frac{6}{48}$. The hearing of the normal ear would be written, H.D. $\frac{48}{48}$. Now we will test the other side, having our patient close his eyes and also his right ear. The watch, as you see, is brought up so as to be in contact with the head, without the patient being able to hear it tick. He can hear the snapping of the finger nails at a distance of two inches from the head, on the left side.

I wish now to have two gentlemen from the class examine this patient's ear, with Dr. Webster, by means of artificial light, and see what they have to report. The case is an interesting one, and one from which we may, I think, get some useful lessons in practice. Here we have one of Politzer's plates giving us a view of the drum-head, as you look down upon it through the external auditory canal. This ridge running downward and backward toward the center of the membrane is the long process of the malleus. This cone-like reflection which you see represented here, projecting from the end of the handle toward the periphery of the drum membrane, is what is called the "light spot," and in the normal ear should have a distinct conical shape. Deviations in the shape of light spots are always noted by careful observers; they say "cone broken," or that it is "in position," or light spot "lighter," light spot "darker," light spot "diffused," light spot "small," or any qualification which will describe the shape or character of the light spot. When you look down upon the natural drum-head of a man at his time of life, you should expect to see the surface slightly inclined toward the anterior wall of the auditory canal, and resembling somewhat in tint gold-beater's skin. Over the malleus and at the periphery there may be a slight increase in the color, due to minute blood vessels. These blood vessels are seldom conspicuous enough to be seen separately in the normal drum-head. Sometimes, however, small vessels may be distinctly seen, but not extending upon the membrane itself. No obvious vascularity is normal, and in that respect the drum-head resembles the cornea. But now, when we look into this man's right ear, instead of finding this ridge running from the periphery of the drum membrane, with a triangular light spot extending from its apex, you see a red surface, and that red surface is irregular. It is obviously the surface of the drum-head, but it is changed in appearance. The surface is red, and just here behind the handle of the malleus, you will see a linear whitish surface in the midst of a red swelling, and it is very probable that this is a wound which was caused by the blow over the opening of the external auditory canal. We examined this patient in the other room, and we concluded that, at the time of the blow, the air was forced in through the external auditory canal with such violence as to have ruptured or torn the drum-head; and the redness which we find is due to traumatic inflammation. We have then a case of rupture of the membrana tympani of the right ear, from a blow, a thing which not infrequently occurs.

We will now speak of its treatment. When I asked the patient what he had done for his ear, he replied that he syringed it out with warm water soon after the accident. I then asked him if he had done it in accordance with the advice of any physician. He said no, that he did it on his own responsibility. My care in ascertaining this was because I did not wish, in my remarks, to cast any reflections upon treatment recommended by his physician, if he had any; for a medical man is always entitled to such doubts as may exist, and there are varieties of judgment. But, if the patient presumed to syringe his ear with warm water after the blow without professional advice, then we are at liberty openly to criticise the procedure as keenly as we like. He says that he syringed his ear with warm water after the blow. I do not think a much worse thing could have been done. I emphasize this procedure in order to condemn it. If I had been called in to see this patient immediately after the injury, and had been sure that rupture of the drum-head existed, I would have been careful not to introduce any substance whatever into the external auditory canal; such for instance as almond oil and the various other "drops" used for ears.

Water poured or thrown into the ear under such circumstances might find its way into the drum cavity, and there it would be a foreign substance. You see this remarkably in cases where the ear douche is used. Many cases of suppurative otitis are due to such an occurrence. Water in the ear, even of a proper temperature, may lead to inflammation and abscess, and hence one of the objections to the use of Thudichum's douche, or any of the other forms of douches. Water is very irritating when in the middle ear, and if there be a rupture of the drum membrane, when water is thrown in through the external auditory canal by means of a syringe, it will find its way into the middle ear and so do harm. This does not hold true in all cases of suppuration of the drum cavity. The indication is to leave the edges of the wound in coaptation, unirritated by any foreign substance. There is no tendency to gape in a wound of this kind. On the contrary, there is a tendency to heal at once. You may demonstrate the existence of a perforation by means of having air whistle through under the pressure of Politzer's inflator, and yet find in the course of twenty-four hours afterward that healing has taken place and the aperture has closed. The proper thing is, then, to put a little cotton into the external canal loosely. Do not make a wad and stuff it into the canal; for, if you do, you will get up a certain amount of hyperæmia of the dermoid tissues, which help to feed the coming congestion of the drum-head. Instead of doing what is commonly done—taking a wad of cotton and thrusting it into the external auditory canal—take a small flock of cotton and lay it loosely in the canal, carrying it in just behind the tragus, so as to sift the air and keep off cold gusts of wind. You not only want to keep out such substances as water, but you wish to keep out cold air. Having done this, put the patient in a condition to use the organ of hearing just as little as possible, so as to give the wound a chance to heal. I do not think it would be good for such a patient to go to a concert, or to engage in an animated discussion, or to be exposed to the noises of the streets. The organ should be allowed to rest, and should be watched. He will have some sensation of dullness in the ear, some sensation of deafness, some sensation of irritation, possibly pain, or, possibly some bleeding; if so, don't wash the blood out, but let it remain. If some of it should dry upon the surface of the drum-head, it will make a scab, and there is nothing better than a scab to protect it. If the drum-head is not much swollen, and is not, as we express it, angry looking, let it alone and it will heal, probably, in the course of twenty-four or thirty-six hours. Now, suppose pain does come on, the drum membrane looking red and angry, and the dermoid textures of the canal participating in the swelling, what would you do then? Here is another one of Politzer's plates, showing the external auditory canal, where one half of the drum membrane has been carried away, so that you may look into the auditory canal and cavity of the drum. Suppose that swelling has taken place, and the skin lining the external auditory canal has swollen so that you see less of the area of the drum than normal, what would you infer? That the process is going beyond what is normal and tending to healing, and is that of inflammation. Having observed this, the next step is to take blood from as near the seat of injury as possible; and, in order to do that, I would recommend that a leech be applied just within the external auditory canal, half an inch perhaps, at the base of the tragus. The way to apply the leech is as follows: take a little mass of absorbent cotton, and gently pack the external auditory canal with it, without inflicting any pain, and be sure that you leave the base of the tragus uncovered, for that is the point to which the leech is to be applied. Then take a cambric needle, or some other sharp pointed instrument, and scratch the skin where you expect the leech to take hold, and then, with a leech-tube, apply the leech, letting it lay hold at the base of the tragus. Allow the leech to fill, and after it has dropped off take a large basin, or bowl of hot water, and, having protected the shoulders of your patient, foment the part with a sponge dipped in the hot water, and so encourage bleeding from the bite for an hour or an hour and a half. The cotton prevents the blood from flowing into the external auditory canal, coagulating, and becoming a source of irritation. When the leechbite does not stop bleeding, you may apply some styptic, as for example, the persulphate of iron, upon cotton.

Having extracted blood in this way, you should give your patient a few hours of rest, and see whether this local depletion may not have accomplished the purpose desired.

If you have applied the leech in the afternoon, and there is still pain after free bleeding, it would be well to give an anodyne, perhaps eight or ten minims of Magendie's solution of morphia, as the case may be, and keep the organ awhile in a state of quiescence by placing over it a large bat of raw cotton. If, upon the following day, pain still continues, then you must begin to apply warm water to the external auditory canal, for by this time the edges of the wound will be so swollen that the water cannot get into the middle ear. The best way is not to throw it in with a syringe, but to pour it in from a spoon or sponge. By this time, as I have said, the wound will have healed, or its lips will be so swollen as to prevent the water from entering the middle ear. The leeching may have to be repeated. These are the simple rules to be followed in such a case of injury to the drum membrane. Now, there was one test which I did not wish to apply here before the gentlemen were asked to see the case in the lighted room, and that is the test by the use of the Politzer bag.

I have here Politzer's inflator, which is simply a rubber air bag, with a valve at its base for the introduction of air; and attached to this is a long black rubber tube, on the end of which is a hard rubber nozzle which fits the nostril. In order to use it, your patient is to take about a teaspoonful of water in his mouth, and hold it there until you tell him to swallow. The hard rubber nozzle is now introduced into the nose, and both nostrils firmly squeezed about it; then you tell your patient to swallow, and the moment you see the larynx move, squeeze the air bag, which will force a column of air through the Eustachian tube. If there be a perforation of the drum membrane, the air may be distinctly felt passing out through the perforation, and a whistling noise will be heard. By this means I find that our patient has a perforation of the drum membrane of the left ear, but none of the right ear. The perforation exists in the ear where the trouble has been for a long time. If we now had, as I have no doubt there has been, a perforation of the drum membrane of the right ear, an experiment such as I have just tried would have given the sign of perforation. I would not have used the Politzer, had I been called in at the time of the accident, for it might have aggravated the trouble; but now, there is a sinking of the drum-head, and an inflation will elevate it and stretch any adhesions that may have formed. There is another method of inflation, which is known as Valsalva's, which consists in closing the nostrils with the forefinger and thumb, and causing the patient to blow from his own lungs up through the Eustachian tubes. This plan is not often employed, for there is an arrest of the venous circulation and congestion

produced, which is unfavorable. We much prefer to employ Politzer's method, which does not increase the inflammation. —*Medical Record.*

JAPANESE INUNDATION FEVER.

UNDER this name (*Japanische Fluss-oder Ueberschwemmungsfieber*), E. Baelz and Kawakami describe, in Virchow's *Archiv*, Band 78, a disease hitherto unknown to Europeans, which breaks out every year, in July and August, in parts that have been inundated during the spring. It is an acute, non-contagious disease, with a typical febrile course, commencing with limited necrosis of the skin, and leading to swelling of the lymphatic glands and a cutaneous eruption. There are no special premonitory symptoms. The onset of the disease takes place generally after six days' residence in the infected locality, with rigors, headache, loss of appetite, and great feeling of debility. The lymphatic glands soon become painful, and the skin in their vicinity rapidly becomes necrosed. This, with the resulting ulcer, is the specific and characteristic sign of the inundation fever, and is never absent. The patients are abnormally sensitive to draughts of air and to the contact of water. The temperature gradually rises, until at the end of the first week it reaches 104° Fahr.; it then remains at this height for eight days, and gradually returns to the normal in the course of the third week. The frequency of the pulse is slightly increased during the fever. A sudden increase in the frequency of the pulse in the third week, when the temperature is normal, is a warning of severe symptoms. On some part of the skin there is formed a dry scab, which, in being thrown off, leaves a crateriform ulcer. The neighboring lymphatic glands swell and become tender to the touch. Catarrh of the conjunctiva is always present. On the fourth or sixth day there generally appears a papular, non-suppurating eruption, first on the face, then on other parts of the body. The exanthem indicates that the disease has reached its acme, and lasts from four to six days; it is attended with continued high fever. At the end of the second week the fever begins to remit, and convalescence rapidly sets in. The mortality is about fifteen per cent. The authors regard the disease as of miasmatic origin. Salicylate of sodium in small doses appears to be useful, while quinine has no effect. In order to prevent the development of the poison, the authors recommend the cultivation in the infected districts of the *Paulownia imperialis*, which possesses many advantages over the eucalyptus.

INFLUENCE OF IMPURE WATER ON HEALTH.

By R. EMMERICH.

A BELIEF that such diseases as typhus and cholera are propagated by means of impure water is prevalent not only among medical men but the general public, and exercises an important influence on the expenditure of town corporations and similar bodies in the endeavor to supply the pure and remove the impure water. The author of the present paper, believing from the experiments of Pettenkofer and others that this deleterious influence either does not exist at all, or if at all, in the most trifling degree, undertook the experiments recorded on the bodies of animals and his own person, in order to contribute to the settlement of the question.

The experiments on animals consisted of subcutaneous injections of distilled, ordinary, and impure waters. The first experiments showed that with rabbits weighing from 760 to 1,500 grammes, the injection of 40–70 c.c. of distilled water produced no observable alteration in their health, and that it required a considerable quantity, fully 200 c.c., to kill them. With impure water different results were obtained. The water selected was from the drain which collects the sewage of part of Munich, and discharges it into a brook; the temperature before injection was kept at blood heat, and the results were uniform, viz., that with animals weighing 550 to 1,500 grammes, quantities of 6 to 60 c.c. invariably caused death in shorter or longer periods, the symptoms differing only according to the amount of the dose and the weight of the animal operated on; the temperature of the body rose in each experiment, but the author hesitates to ascribe that effect to the oxidation of the impurities of the water. With *boiled* sewage water the results were very similar to those with clean water, 14–24 c.c. producing but slight sickness, quickly recovered from, and death taking place only after injection of comparatively large quantities, say 150 c.c. Two other experiments were made with the residue of evaporated sewage water; 500 c.c. evaporated on the water bath and dissolved in a small quantity of distilled water; the injection of this matter produced strong convulsions and speedy death. The net result of this first series of experiments shows that the subcutaneous injection of impure water causes symptoms quite analogous to those produced by putrid fluids, and that its effects are the more intense the greater the quantity of oxidizable impurity combined in the water.

These experiments do not show whether the poisonous matter is in solution or suspension, or whether or not it is an organized ferment; but the author inclines to the opinion that it is *not* an organism, and that the similarity of the behavior of the boiled sewage and its extracted residue with other preparations of putrid solutions leads him to the belief that the poisonous qualities are due to putrefactive matter in the sewage.

The author next directed his attention to the introduction of impure water into the stomachs of animals, and the results agree very closely with other experiments made with putrid poisons, viz., that a much larger quantity can be introduced into the stomach than either into the veins or under the skin. In the present case a rabbit weighing 1,500 grammes received daily 600 c.c. of sewage water in four doses of 150 c.c. At the end of two days the animal appeared unharmed.

The author thinks it would be unsafe to say that the effects on human beings would be the same as on animals, and if the poison be an alkaloid or anything of that nature —say, similar to morphine—its toxical effects would vary very considerably; and taking into account the slight effect of large doses on such small animals as rabbits, he is of opinion that human beings could with impunity partake daily of a considerable quantity of sewage water. To test the matter, he determined to drink daily one-half to one whole liter of water taken from one of the small brooks or water courses of Munich, which received the drainage from kitchens, washhouses, urinals, cattle sheds, etc.; moreover, there were cases of typhoid in some of the houses draining into it, on the surface floated cabbage and lettuce leaves, human and animal hair, etc. He continued the experiment "a long time," not exactly defined, but without feeling any injurious effects. A slight stomach cough with which he was affected at the beginning of the observations did not become any worse; and he inclines to the opinion that the unpleasant effects experienced by other people may have arisen from feelings of nausea at the appearance of the water. The author invites other investigators to continue similar experiments.

Injections of largely diluted sewage yield negative results, and the author agrees with Nägeli that the addition of large quantities of water to sewage renders the poisonous matter innocuous.

The author proposes a rough method of investigating the evil effects of impure water, which is, that the suspected water or its residue dissolved in 40 to 80 c.c. be injected under the skin of a full-grown rabbit; if the increase of temperature is no greater than 1° C., or if death do not follow in a very short time, there is no hurtful matter present, or it is present in trifling quantity.

He has examined the worst of the Munich waters by this method and thinks it fairly trustworthy, but that it, in common with all known processes for estimating organic impurities in water, must be considered as temporary expedients to give way to some method yet to be devised.—*Bied. Centr.*

COTTON SEED OIL CAKE AS A FERTILIZER AND FOOD.

By WM. L. DUDLEY, Prof. Analytical Chemistry and Toxicology, Miami Medical College, Cincinnati, O.

IT is but a few years since cotton seed was, for the most part, wasted. After the farmer used sufficient for planting, the remainder was cast off in some obscure spot to decay. But look at the change. See within the last few years how the seed is sought. The farmers in the South can sell all the seed they possess, and even then the demand is unsupplied. Some persons unacquainted with the subject may ask, "What is done with this enormous quantity of seed that is ginned in the South every year? Who buys it?" It is bought by the oil mills. It is only of late years that the commercial value of cotton seed oil has become known; but after the seed has been hulled, ground to meal, and the oil expressed, there is still another very important use for the remains, known as the "oil cake." This cake is extensively used as a fertilizer and food for stock, and its great value is becoming appreciated more and more each succeeding year.

The value of any manure depends almost entirely on the nitrogen, phosphoric acid, and potash which it contains. It is these three constituents in which the cotton cake is especially rich. The following table gives the comparative analyses of the various vegetable fertilizers:

COMPOSITION OF ORDINARY FEEDING-STUFFS IN 1,000 PARTS.

	Dry matter.	Nitrogen.	Potash.	Phosphoric acid.
Cotton cake (decorticated)..	900	66	15?	31·2
Rape cake	900	48	13·2	24·6
Linseed cake.....	885	45	14·7	19·6
Cotton cake (undecorticated)	885	37	20·1	22·9
Linseed.....	905	36	12·3	15·4
Palm-kernel meal (English).	930	25	5·5	12·2
Beans....	850	40	12	11·6
Peas.....	860	36	9·8	8·8
Malt dust.....	905	38	19·5	17·2
Bran.....	865	22	14·8	32·3
Oats.....	860	20	4·5	6·2
Wheat	850	18	5·4	8
Barley.....	840	16·5	4·9	7·3
Maize.....	880	16	3·6	6·1
Clover hay...	840	23	19·5	5·6
Meadow hay.....	840	14·6	16·8	3·8
Bean straw.....	825	10	25·9	4·1
Wheat straw.....	840	4	5·8	2·6
Barley straw	850	5	9·7	2
Oat straw.....	830	5	10·4	2·5
Potatoes.....	250	3·5	5·6	1·8
Mangels.....	115	2	3·9	0·7
Swedes.....	107	2·3	2	0·6
Carrots.....	142	1·6	3·3	1
Turnips.....	82	1·9	2·9	0·6

By examining the above table it will be seen that the cake obtained from decorticated cotton seed contains the greatest proportion of the valuable constituents for a fertilizer and food. If the whole seeds be used as manure they have very little value, since if sprouting does not take place the hull excludes the air and moisture from the fleshy part of the seed, and thus decay is delayed for a long time; furthermore, the oil which is present also has a tendency to preserve the seed, and consequently during all this time it is useless as a fertilizer; but in the condition in which we find the cotton cake, it is admirably adapted for its purpose. In the first place, the hull has been removed; secondly, it has been thoroughly pulverized; and thirdly, the oil has been extracted. Although the cake is in a most favorable condition for speedy decomposition when exposed to the action of the soil, atmosphere, and moisture, yet it may be kept in a barn or any dry place without the slightest danger of decay.

When we consider how few American farmers appreciate the value of fertilizers, we cannot help expressing astonishment. It is a most remarkable fact that nearly all of this cotton cake is shipped abroad where it finds ready sale. The European farmer knows the value of it; his land has been worked over and over again until it is almost impossible for him to utilize it without artificial aid. But the American farmer never thinks about exhausting his land; he works it until it is of little more value than a sand heap, then he abandons it or possibly sows grass seed on it, and clears a new patch, which is subjected to the same treatment. But our farmers are gradually finding out the importance of preserving the land, especially those of the North and East, since the land in that section is much more expensive and limited than that of the West and South. I think any sensible man, when his attention is drawn to the subject, will see the benefit derived from fertilization. Let him consider how the land is to keep up the supply of nourishment which is being continually drawn from it, when nothing is added to supply the place. To be sure, some nitrogen may be derived from the atmosphere, but where is the phosphoric acid and potash to come from unless it is added by artificial means.

Farmers think it useless for their boys to have a good education, when in reality it is most desirable. How much better would he be able to take care of his land, if he understood chemistry for instance! No two plants require the same nourishment. The manure that is of great benefit to one plant is of very little use to another, and if the farmer knew this he could put his money and labor to the best advantage. He would know whether his ground required a bone fertilizer, feeding stuff, or farm yard manure, in order to produce the largest yield of a certain crop. And what is of more importance to him?

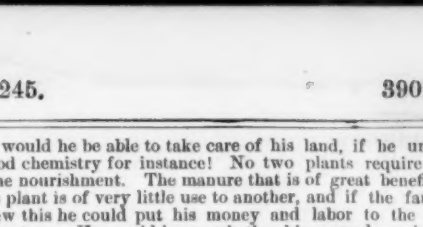
The superiority of cotton cake as a food for cattle has been recognized as far back as 1864 by the Department of Agriculture at Washington. In the report for that year, page 275, it says: "One of the most valuable of all artificial foods is cotton seed meal." It also states that the meal made from the decorticated seed is of about twice the value of the whole seed meal. Several cases are on record where the whole seed meal has produced death in young animals, owing to the indigestibility of the hard hull; but the decorticated seed meal may be fed with impunity.

The value of this food for cattle will be seen from the following, contained in the report of the Department of Agriculture for 1869, page 284: "Horace Colburn, of Winslow, Maine, in November, 1868, purchased five hundred pounds of cotton seed meal and the same weight of fine seed, and commenced feeding two quarts of each material per cow, in addition to hay. In one week the cows thus fed doubled their yield of milk, the product being also improved in quality, while the animal made a decided gain in appearance." In the same report, page 440, one farmer states that in summer he gives each cow two quarts of cotton seed meal daily, in addition to pasturage; in winter four quarts of cotton seed meal and two to four quarts of Indian meal, with English and swale hay. If out of cotton seed meal one day, his cows shrink one quart each, and neither Indian meal nor wheat shorts will bring them up to the full quantity; after again feeding the cotton seed meal once a day, they regain their usual product. Another correspondent used a mixture similar to the above, and the yield of milk increased from twelve quarts to eighteen quarts daily.

Some difficulty may be experienced at first in getting the stock to eat the cotton cake, but by mixing it with other fine food this trouble will be avoided. As soon as the taste of the animal becomes accustomed to it, no further difficulty need be apprehended.

THE CYCLOGRAPH.

THE accurate delineation of arcs of large radius is a problem whose solution is not unattended by great difficulties. In large class rooms where drawing is taught, the compass used consists of a light wooden rule, one end of which is fixed at the center, and the other carries the crayon. The flexibility of the wood, however, renders the curves drawn in this way as inexact as the process is inconvenient. The method of ordinates may also be employed, certain points being calculated which serve afterward, when joined, to trace the general curve. But such work is wearisome, and gives only approximate results.



The apparatus represented herewith, invented by Mr. T. P. Worthington, an architect at Blackpool, gives a means of resolving the problem in a neat and simple manner.

To explain the principle, let us imagine a ten-cent piece and a five-cent piece, both fixed parallel to each other on the same axis, like two unequal-sized wheels, on one axle. Now, by rolling such an apparatus over a plane surface—a drawing board, for example—the circumferences of the two coins will each describe a circle having a common center, and the diameter of which will depend on the distance which separates the two coins, the radius increasing with the distance of the two pieces and *vice versa*. In Mr. Worthington's apparatus, which he calls the "grapharc," the pieces of money are substituted by two disks, A and B, and the axis is composed of a graduated rod, provided with a handle, D, and a pencil.

To draw a curve with this instrument, it is only necessary to arrange the wheels at a proper distance apart, according to the graduation of the rod. According to the position of the wheel, B, on the axis, C, the apparatus will draw curves whose radius varies between one and five meters; but with a set of wheels B, properly combined, curves of any radius whatever may be drawn. Thus, for instance, with a cyclograph whose wheel, A, has a diameter of scarcely seven centimeters, and four wheels, B, of suitable dimensions, all curves may be drawn which have a radius varying between one and twenty meters; and with a large number of exchangeable wheels, the apparatus will draw curves having a radius of as much as three thousand meters. It should be stated that the wheel, A, is graduated; so that after the curve is drawn, its exact length may be known, and, by a very simple calculation, the value in degrees of the arc passed over. The apparatus is very simple, easy to use, and very exact.

NOTES RESPECTING THE ROYAL OBSERVATORY.

THE Royal Observatory, Greenwich, is situated nearly in the center of Greenwich Park, and was built in the year 1676 by order of Charles II. It was devoted almost exclusively to astronomical observations till 1840. In that year regular magnetical and meteorological observations were begun, and for seven years observations were made every two hours night and day. On some days, indeed, observations were made every five minutes for twenty-four hours consecutively, and on days of magnetic disturbances the observations were made continuously, so long as the disturbance lasted. The movements of the magnets are of so delicate a nature that nothing in the shape of a pencil could be attached to them to trace their movements, and no means, except the use of an imponderable agent like light, could be used for that purpose.

About this time two gentlemen—viz., the late Sir Francis Ronalds, F.R.S., and the late C. Brooke, Esq., F.R.S.—made experiments to register these delicate movements by means of photography, and from the year 1848 all magnetical and

some meteorological observations have been recorded by means of the system perfected by Mr. Brooke.

His principle is a bar magnet and a concave mirror, supported by a single thread; an ebonite cylinder wrapped round with photographic paper; a plano-convex lens; a lamp placed a little out of the line which joins the centers of the cylinder and magnet in operation. A pencil of light passes through a very narrow aperture, diverges and spreads over the mirror, from which it is reflected and diverges to the lens, and is condensed into a well defined spot of light at the surface of the paper. The action of this spot upon the photographic paper is to leave a trace, which is, however, imperceptible until subsequently revealed by the application of a developing solution.

The principle adopted for all instruments is the same. For the register of each indication, a cylinder is provided whose material is ebonite, and which is accurately turned in a lathe. The axis of the cylinder is placed parallel to the direction of the change of indication which is to be registered. If there are two indications whose movements are in the same direction, both may be registered on the same cylinder; one on the one side, and the other on the other, keeping their traces separate, as shown by the two zigzag lines, one at either end of the cylinder, in the preceding woodcut.

MAGNETIC ELEMENTS.

The magnets in use at the Observatory are of hard steel, 2 feet in length, 1½ inch in breadth, and ¼ of an inch in thickness.

If a magnet be suspended by its middle point, it would settle in the magnetic meridian, now about 18½° west of the true meridian (which angle is technically called declination, or, popularly, variation of the compass) and inclined at an angle with the horizon of about 67½° (technically called the dip), and would be subject to diurnal changes, both right and left and up and down, as well as permanent changes of position from year to year. The value of the declination in the year 1840 was about 23½°, and that of the dip was 69°.

In practice, the declination magnet is suspended so as to be horizontal, and the changes right and left will be the same as in the inclined position; and the investigation of the diurnal changes of the dip are found by the use of two magnets, one called the horizontal force magnet, and the other the vertical force magnet. By combining the results found by the use of these magnets the variations of the dip are known

A horizontal revolving cylinder will register the continuous records of both declination and of horizontal force.

The continuous record of vertical force necessitates the use of a vertical revolving cylinder.

ATMOSPHERIC PRESSURE.

The continuous record of atmospheric pressure is obtained by means of a siphon barometer; on the mercury, in the lower leg, is placed a glass float, partly immersed in the mercury; to the float is attached a vertical rod, supported by a horizontal bar which carries a vertical plate of mica having a small horizontal slit; through this slit the light of a lamp falls on a cylindrical lens, and from thence to the photographic paper.

The scale of the barometer is about four inches on the paper to a change of one inch in the reading of the barometer, and these changes, being vertical, can be registered on the same cylinder as that devoted to the vertical force.

SPONTANEOUS EARTH CURRENTS.

It is well known that spontaneous galvanic currents are almost always passing in the earth, and are at times very powerful, and frequently troublesome in telegraph offices. These earth currents are registered at Greenwich by means of photography. There are two wires crossing each other near the Observatory; these wires, from an earth connection at the Royal Observatory, extend in two directions nearly at right angles to each other to considerable distances from the Observatory, where they again make earth connection. Two magnetic needles, one for each wire, each suspended by a hair, so as to vibrate horizontally within a galvanometer, are placed respectively in the courses of the two wires. A current of one kind, in either wire, causes the corresponding needle to turn itself in one direction; a current of the opposite kind, in the other direction.

To the carrier of each magnet is fixed a small plane mirror, which receives all the motions of the magnet. The light of a gas lamp passes through a small aperture, and shines upon the mirror. A spot of light is thus formed upon the photographic paper wrapped upon the cylinder.

DRY AND WET BULB THERMOMETERS FOR TEMPERATURE OF THE AIR AND EVAPORATION.

These of necessity must be out of doors, and their bulbs open to all changes of temperature and humidity. The bulb of the thermometer employed as wet bulb is kept moist by the capillary passage of water along cotton lamp wicks leading from a vessel of water. The bulbs are eight inches in length, and their centers about four feet above the ground.

A vertical revolving cylinder and the carrying timepiece are mounted on a stand measuring thirty inches by twelve, supported by four legs; the stems of the dry and wet bulb thermometers pass up through the table and between the lenses and the adjacent surfaces of the cylinder; the long cylindrical bulbs are sufficiently below the stand to be freely influenced by the currents of air, and, at the same time, to remain wholly unaffected by the heat of the lamps, which are placed on wooden supports at each end of the stand, at such a height that the flame may be opposite the middle of the photographic paper on the cylinder.

As it is impossible to superpose two registers of these instruments on the same paper, which may be done without inconvenience when the indication consists of a dark line only, as in the photographs of the barometer and the magnetometers, the timepiece is so constructed that the hour hand makes half a revolution in twenty-five hours. By this arrangement the two halves of the paper surrounding the cylinder give respectively a perfect record of the two instruments. The glass cylinder is covered by a concentric cylindrical zinc case, having slits on opposite sides corresponding to the stems of the instruments, which are capable of being closed by sliding doors; by these means the cylinder, protected by its case, may be carried to or from the room in which the photographic manipulations are conducted without any risk of exposure to light. The whole apparatus is also covered by a wind and water tight zinc case which rests on the stand, and is divided into separate compartments for the lamps by a partition towards each end for the purpose of more completely isolating the thermometers from the heat produced by their combustion.

The cylindrical arrangement above described, so obviously desirable in enabling the two thermometric instruments to be registered by one apparatus and on one piece of paper, was at first open to a grave objection, which has, however, subsequently been entirely removed. This has been effected by placing fine wires opposite to each degree across the aperture in the scale frame, through which the light is transmitted to the stem of the instrument.

By these wires a minute portion of the exposed paper is protected from light, and thus the darkened portion of the register is traversed by a series of parallel lines corresponding with the scale of the thermometer. In order to remove any ambiguity in the reading of this scale, a coarser wire is placed at every ten degrees, and an additional coarse wire at the points 22°, 54°, 76°, and 98°; as one of these points may always be made to appear on the register, the relative position of the extra coarse wire will determine the points of the scale which it represents.

It is very evident that the apparatus must afford some ready method of marking the time scale on the paper—that is, of identifying any given epoch of time with the indications of the register. This is effected by closing at any two known times the sliding doors of the cylindrical case for five minutes, and then reopening them. Two undarkened lines will be observed on the paper, corresponding to the known time.

The scales of the thermometers in use have about 80° to one inch, from the registers of which the temperature may be easily read. Of this scale, a space of about 60° may be illuminated at one time, and in order that the temperature indicated may always be within the field, the thermometers are capable of being raised or lowered by a screw, so as to bring the mean temperature of the season nearly opposite the middle of the paper; thus there is no probability that the record of any unusual and extreme changes of temperature will be lost.

Uniform rotatory motion is given to the cylinders by the action of clock work; for two of the cylinders, which revolve in twenty-four hours, and for the thermometer cylinder, which revolves in fifty hours, the axis is placed opposite to the center of the chronometer, and a fork at the end of the hour hand takes hold of a winch fixed to the plate of the cylinder. For the horizontal cylinders the plane of the chronometer work is vertical, for the vertical cylinders it is horizontal. The cylinders employed for the declination and horizontal force registers, for the vertical force and barometer registers, and for the earth current registers, are 11½ inches high, and 14½ inches in circumference; those for the thermometers are 10 inches high, and 19 inches in circumference.

Each cylinder is covered, when in use, by a tube of glass which is open at one end, and has at the other end a circular plate of ebonite or brass, perforated at its center. The tube is a little larger than the cylinder. Its open end is kept in position by a narrow collar of ebonite, and the opposite end by a circular piece of brass fixed to the smaller brass plate at the end of the cylinder.

To prepare the cylinder for register of indications, it is covered with a sheet of sensitized paper (the moisture on the paper usually causes the overlapping ends to adhere with sufficient firmness); the glass tube is then slipped over it, and the cylinder thus loaded is placed (if horizontal) with its pivots in bearing upon its two sets of antifriction wheels; or, if vertical, with its end brass plate upon a rotating brass plate, and its central perforation upon the spindle of that plate. Care is taken to insure connection with the clock work, and the apparatus is ready for action.

The trace for each instrument is produced by a flame of coal gas usually charged with the vapor of naphtha. For the magnetometers the light shines through a small aperture about 0·3 in. long, and 0·01 in. broad; for the earth current apparatus and for the barometer the aperture is larger. The arrangements for throwing on the photographic paper of the revolving cylinder a spot of light which shall travel in the direction of the cylinder's axis with every motion of either magnetometer or galvanometer, or with the rise and fall of the mercury in the barometer, are as follows: For each of the three magnetometers a large concave mirror of speculum metal is carried by a part of the magnet carrier; although it has a small movement of adjustment relative to the magnet carrier, yet in practice it is very firmly clamped to it, so that the mirror receives all the angular movements of the magnet. The lamp above mentioned is placed slightly out of the direction of the straight line drawn from the center of the concave mirror to the center of the cylinder which carries the photographic paper. By the concave mirror the light diverging from the aperture is made to converge to a system of plano convex cylindrical lenses of glass, with their axes parallel to the axis of the cylinder, and the image is thus reduced to a bright spot of light.

CHEMICAL OPERATION FOR THE PHOTOGRAPHIC RECORDS.

Sixteen grains of iodide of potassium are dissolved in one ounce of distilled water; twenty-four grains of bromide of potassium are dissolved in one ounce of distilled water. When the crystals are dissolved, the two solutions are mixed together, forming the iodizing solution. The mixture will keep through any length of time. Immediately before use it is filtered through filtering paper. A quantity of the paper sufficient for the consumption of several weeks is treated in the following manner, sheet after sheet: The sheet of paper is pinned by its four corners to a horizontal board. Upon the paper a sufficient quantity (about fifty minims or five-forty-eighths of an ounce troy) of the iodizing solution is applied by pouring it upon the paper in front of a glass rod, which is then moved to and fro till the whole surface is uniformly wetted by the solution; or the solution may be evenly distributed by means of a camel's hair brush. The paper thus prepared is allowed to remain in a horizontal position for a few minutes, and is then hung up to dry in the air; when dry, it is placed in a drawer, and may be kept through any length of time.

A solution of nitrate of silver is prepared by dissolving 50 grains of crystallized nitrate of silver in one ounce of distilled water, to which 15 grains of acetic acid are added. Then the following operation is performed in a room illuminated by yellow light. The paper is pinned as before upon a board somewhat smaller than itself, and (by means of a glass rod as before) its surface is wetted with 50 minims of the nitrate of silver solution. It is allowed to remain a short time in a horizontal position, and if any part of the paper still shines from the presence of a part of the solution unabsorbed into its texture, the superfluous fluid is taken off by the application of blotting paper.

The paper, still damp, is immediately placed upon the cylinder, and is covered by the exterior glass tube, and the cylinder is mounted upon the revolving apparatus to receive the spot of light formed by the mirror, which is carried by the magnet, or to receive the line of light passing through the thermometer tube.

When the paper is removed from the cylinder, it is placed, as before, upon a board, and a saturated solution of gallic acid, to which a few drops of aceto nitrate of silver are occasionally added, is spread over the paper by means of a glass rod, and this action is continued until the trace is fully developed. The solutions are kept in the magnetic basement, and are always used at the temperature of that room. When the trace is well developed, the paper is placed in a vessel with water, and repeatedly washed with several changes of water, a brush being passed lightly over both sides of the paper, to remove any crystalline deposit.

The photograph is placed in a solution of hyposulphite of soda, made by dissolving four or five ounces of the hyposulphite in a pint of water; it is plunged completely in the liquid, and allowed to remain from one to two hours, until the yellow tint of the iodide of silver is removed. After this the sheet is washed repeatedly with water, allowed to remain immersed in water for twenty-four hours, and afterwards placed within folds of cotton cloths till nearly dry. Finally, it is placed between sheets of blotting paper, and is pressed.

At all times the greatest care has been paid to cleanliness. White earthenware vessels were used from almost the beginning, and an abundance of water has always been freely used, and there is but little fading even in the earliest negatives. Photography has given continuous traces for many years of their different elements, needing only a few observations by the eye, taken during the hours of day, to convert them into true values of the different subjects of investigation, so that all-night work has now ceased for many years in this department of the Observatory, due entirely to this application of photography.—*Photographic News.*

COPPER IN PLANTS WHICH GROW ON PRIMORDIAL ROCKS.

By DIEULAFAIT.

THE author has previously shown that all rocks of primordial formation contain copper. He finds that this element is present in plants growing on such rocks to such an extent that it may be recognized by the ammonia reaction in one gramme of ash. Copper is also present in the ashes of plants growing on marls, the sand of which has been derived from primordial rocks. Other researches have led the author to conclude that heat has had nothing to do with the formation of dolomites. They are marine formations, sedimentary in the ordinary sense of the word, but often deposited in concentrated marine waters. He has previously found that deposits found in such waters always contain copper, therefore dolomites ought to contain this element. Plants growing on dolomites contain copper to such an amount that it can be detected in one gramme of ash. On the other hand, plants growing on pure limestones contain but traces of this metal, requiring at least one hundred grammes of ash for its detection.

THE GEYSER REGION IN THE NATIONAL PARK.

THE *Ausland*, a German periodical on natural sciences, contains an article in its number of May 10, written by Dr. Otto Kuntze, on the Geyser Region in the National Park, in which the maps and illustrations of Professor F. V. Hayden, United States Geologist, and also the descriptions of Cavalry-Lieutenant Gustave Doane are criticised and declared to be partly incorrect. We quote from this article the following:

When I visited the geyser region in the National Park of the United States, and the region of the Japanic geysers at Atami, in the peninsula of Simoda, I observed some facts which are able to extend our knowledge regarding the geyser phenomena, and also show that the maps, illustrations, and descriptions published by Professor F. V. Hayden, United States Geologist, which are reproduced in Petermann's Geogr. Mittheilungen, 1872, Table 13, pp. 241 and 321 a. f., are partially incorrect. The illustrated and reproduced description of these geysers, which was first published in the "Globus," 1875, p. 290, a. f., requires, also, many corrections. In regard to this latter description we will only enter into a criticism of the actual mistakes of the illustrations, which are in general good, and we will speak of the description in so far as it may be considered a supplement of Mr. Hayden's report, for the simple reason that Mr. Doane's description is so full of exaggerations and improbabilities, that a full criticism would require too much space. First, to speak of the picture of the Giantess Geyser (Peterm. Mitth., 1872, Table 13). This picture must be called incorrect. From the morning of October 5 until noon of October 9, 1874, I was in the geyser region of the Firehole River. The Giantess Geyser I observed gushing at three different times, but only twice in the day time. The water sprang out of a funnel-shaped basin (23½ feet long, 32½ feet wide, 36 feet deep), but not at all to a height of 60 feet, as Hayden says, nor yet to 90 feet, as Doane says. Then followed five streams of water of a thickness from five-sixteenths inch, which reached the height of about 150 feet. These streams are mentioned by Hayden in the description, but are not to be found in the picture. They are always united either to one stream or all thrown out at the same time. They are not vertical, but inclined, and have mostly a northerly direction. Finally, there bursts forth a stream to the south, which surprised us, for we thought that in that direction the position was secure. Hayden gives the height of the stream as 250 feet; Doane even as 500 feet. These indications of height are based on guesses—a very dangerous kind of measurement for high and slender objects, as any one who doubts it may find if he tries by this method to measure the height of an isolated chimney. The mineralogist, Dr. A. C. Peale, who visited the geyser region in 1872, and explored it more thoroughly (compare Sixth Annual Report of the United States Geological Survey, p. 140), measured only 39 feet as the maximum height of the watershoot. We must assume that the Giantess Geyser has several channels, which have one common outlet, because this geyser, different from all other geysers, makes no equal poses in its eruptions; therefore, the watershoot may not always be of the same height. This may partially explain the difference in the reports.

The picture, "View of the Lower Geyser Basin, seen from the Twin Buttes," is only a fantastic conception. Curiously enough this picture is wanting in Hayden's official report, entitled 5th and 6th Annual Report, 1872, 1873, although in the 5th Report, p. 112, it is several times indicated.

In this picture are the following errors: (1.) The geysers appear to be all springing at the same time. In the texts of Messrs. Hayden and Doane this is also shown to be an error; for, when each of the geysers has equal poses and duration of eruptions, and when these are different, as the texts say, for each geyser, then they cannot spring at the

same time. Only four small geysers, situated very near to each other east from the grand geyser, are known to have their eruptions simultaneously; and these should rather be called a fourfold geyser. (2.) Instead of 22 geysers I found in the "lower basin" only 3 active ones. Peale speaks of 6, of which 2 might be only steam ventiles. Hayden describes more explicitly only the (active?) Thud Geyser and the Fountain Geyser; the latter as having a shoot of from 30 to 60 feet. Besides, he speaks of "a considerable number, which have a shoot from 2 to 10 feet in height." According to my observations these shoots are only steam, which, when it is windy, rise from the ground in an inclined direction, while the picture shows 22 vertical shoots of water with inclined steam shoots. In another place (*Americ. Journ. of Science*, 1872, p. 168) Professor Hayden says, contradicting himself, that only a few of the thousands of hot springs in the lower basin are throwing real columns of water, and may be called geysers. (3.) The height of the geysers in the picture is incorrect. The pine trees which surround the geysers are, in the picture, from four to six times smaller than the geysers themselves. These trees are, as Professor Hayden says, 100 to 150 feet high, and have a diameter of 6 to 12 inches (*Americ. Journ. of Science*, 1872, 165); therefore the geysers would have a height of from 400 to 900 feet, while the highest of the few geysers known in the lower basin is only from 60 to 80 feet high.

Now we come to speak about the map, which has the title "The Geyser Region at the Firehole River." According to this map there must exist 9 extinguished and about 500 active geysers, if, as the map says, a dot indicates an active and a small circle an extinguished geyser. (But we must say that Hayden's maps are not with great exactitude reproduced, and the texts accompanying, by their unclear expressions, gave origin to misunderstandings.)

Now there are only those 30 geysers in the whole National Park which we have registered on our map given below, which were published later, show simply silica and no lime. On the Firehole River there are none but silica craters.

Of sulphur incrustations, which are said to be so frequent in other parts of the National Park, Doane has a real mania for discovering sulphur incrustations. I found neither in the upper basin nor the lower basin any traces. Hayden says, in describing the geyser basin on the East Fork (*Americ. Journ. of Science*, 1872, p. 166): "All those little chimneys and openings were lined with beautiful sulphur-crystals, and upon removing the hot crust we found underneath it the same kind of ornament." I saw nothing of that kind; the many specimens I brought along are perfectly free from sulphur.

Another communication of Professor Hayden (5th Annual Report, p. 108), according to which only very few springs have precipitated some sulphur in the Firehole Valley, is in direct contradiction to the above statement, for the extinguished geysers and hot springs of the East Fork region, which he describes as so beautifully lined with sulphur crystals, are near the place where the East Fork empties into the Firehole River and belong to the Firehole Valley proper.

Doane gives a panoramic view of the upper basin ("Globus," p. 323), in which Castle, Grotto, Fan, Giantess, and Beehive Geysers are shown to be springing at the same time. We see, also, in this picture, openings throwing out steam in midst of thick forest. This gives a very wrong impression, for wherever such geysers occur the surrounding forest is destroyed by them. The height of the column of the watershoot of the Fan Geyser ("Globus," p. 324) is exaggerated and the drawing is otherwise incorrect, because the two active craters—not five, as Hayden says—belonging to two different geysers, are, in the picture, throwing their water columns at the same time across the Firehole River. In reality this is not the case. The one geyser—we may call it the Front Fan Geyser—throws, during a period of twenty minutes, a column of water to the height of 60 feet, always

TABLE OF THE ACTIVE GEYSERS IN THE NATIONAL PARK.

Name of Geyser.	Pause between the Eruptions.	Duration of Eruption.	Height of the Shoot.	Time of Observation.	Observers.
1. Mud	3 hours	15½ minutes	30'*	1 Aug., 1871	Carrington.
"	4h. 11m.	12m. 27s.	18–40'*	11–12 Aug., 1872.	Peale.
2. Fountain	——	——	60'*	3 Aug., 1871	Hayden !
3. Great Fountain	about 2 hours	about 1 hour	80'*	13–16 Aug., 1872.	Holmes.
4. Steady ?	——	——	30'*	——	Peale.
5. Jet ?	——	——	30'*	——	Peale.
6–7. Little	about 1h. 13m.	——	20'*	——	Hayden!
8. Grand	——	20 minutes	200'*	5 Aug., 1871	Hayden.
"	22½ and 24½ hours.	15, 37, 32 (16) m.	173'†	18–20 Aug., 1872.	Peale.
9. Castle	——	——	60'†	1870.	Doane.
"	21½ hours	15¼ minutes (?).	93'†	18–20 Aug., 1872.	Peale.
" (side opening).	short pauses	——	——	1871.	Hayden.
10. Giant	month; 3 days!	80 minutes	140'†	1871.	Hayden.
"	——	180 minutes ?	200'*	1870.	Doane.
11. Giantess	about 13½ hours.	20 minutes	200'–? 500'*	1870–71.	Doane, Hayden
"	after a long pause 2–3	20 + 60 m.	150'*	1874.	!
"	times per ½ hour.	——	39'†	18 Aug., 1872	Peale.
12. Beehive	——	18 minutes	219'†	1871.	Hayden & os.
	21¾ to 25½ hours.	4½ + 15 m.	——	18–20 Aug., 1872.	Peale.
		16 minutes	——	8 of Oct., 1874	!
13. Old Faithful	60 to 66 minutes	5 minutes	130'†	1870–74.	all visitors.
14. Grotto	——	——	50'*	1870.	Doane.
"	about 3 days?	125½ minutes	41'†	Aug., 1872	Peale.
——		150 minutes	——	8 Oct., '74(1:30–3)	!
——					
15. Blacksand	short pauses	——	50'*	Oct., 1874	!
16. Punch Bowl	"	——	50'*	"	!
17. Soda	4 minutes	1 minute	50'*	"	!
18. Nameless	24 hours	13 minutes	120'*	1½ p.m. 7–8 O., '74.	!
19a. Latter Fan	——	30 minutes	40'*	1:30 p.m., 1874	!
19b. Front Fan	——	20 minutes	60'*	1–1:20 p. m., '74.	!
20. Boiling Lake	short pauses	——	40' + 80'*	3p.m., 7 Oct., '74.	!
21. Quadruple	——	——	10' + 20'*	1871.	Hayden.
22. River-Side ?	——	——	80'?*	1871.	Holmes.
23. Turban	——	¼ minute	25'†	20 Aug., 1872	Peale, Bradly.
24. Sawmill	——	——	20'*	——	"
25. Solitary	——	4 + 26 m.	70'*	3 Sept., 1872	Bradly.
26. Union	nearly 2½ hours.	47 + 56 m. (52).		7 Sept., 1872	"
——		water, steam	50'*	"	"
a		10 + 42 m.	90'*	"	"
b		5 + 47 m.	3'*	"	"
c		2 + 50 m.		"	"
27. Minute Man	several hours	some hours,		"	"
		with steam pauses,		"	"
		2–3 m.	40'*	"	"
28. Shield	few hours	——	——	"	"
29. Twins	long pause	——	not high*	"	"
30. Flat Mount	short pause	——	30 feet*	"	"

* Found by guessing. † Found by measuring.

known to be active geysers (23 of them belong to the Firehole Basin); while all the others have to be considered as extinguished or steam-throwing, or perhaps as pulsing basins. This does not exclude the fact that after further explorations several of these basins may in future times be found active, but as to my knowledge there exist only these 30; and Hayden, who, with his companions, spent only from the 2d to the 6th of August, 1871, that is 4½ days, the same space of time as I, will scarcely have seen more eruptions than I, and quite as unjustified and incorrect is it for him to give to eight groups of springs, steam-ventiles, basins, and extinguished craters, the name of geysers.

There are, besides, several smaller mistakes on this map of which we will not speak particularly for want of space; we only mention that the waste of the geyser water is shown on the map to be running in small creeks, while this is, in fact, not the case, for the water is expanded and distributes itself into numerous little furrows as it courses away. Most of the water runs back into the geyser craters, only a small amount finding its way to the river; therefore, the water in the river is scarcely any warmer in the geyser region than elsewhere. I found that this water near the geysers had a temperature which was only 1° R. higher than that which was measured about a day's travel upward.

Doane speaks, in his description, very often of lime as forming the craters and their surroundings, while they only consist of silicious scale. I brought with me a great number of specimens, of which none were effervescent when acted upon by acids. The chemical analyses of geyserites, of the same diameter, while at the same time there occasionally rises a shoot to the height of 8 feet from the main crater. Ten minutes later, a second opening, which we may call the Rear Fan Geyser, throws, for thirty minutes, a water column to the height of 40 feet. The directions of the two columns, which are never seen at the same time, cross each other.

The geyser phenomena—Giantess appears to be an exception—repeat themselves, as far as is known, with great regularity; the excuse that the same geyser may have, several years ago, thrown out its columns in a different manner, can, therefore, not be accepted. Equally invalid would be the excuse that the phenomena may have changed in time, on account of the incrustation of the craters. These incrustations form so slowly* that it would take perhaps centuries to alter the pauses and the durations of the eruptions to any perceptible degree.

To obtain a correct knowledge of these phenomena exact registrations are necessary, and perhaps the comparative table which we give above might be of some value for this purpose. My own observations, and those by the other authors which I could indorse, are indicated by an exclamation (!) sign.

* How slowly the incrustations form may be seen by the following: In a basin where warm geyser-water is continually flowing, some travelers, who visited this place two and three years ago, had written with lead pencils upon the white flat stones which lay under the water, their names and the dates of their visit, and since then the stones had incrusted so little that the writing was as plain as if it had been done but yesterday.

THE GEOLOGICAL HISTORY OF THE NORTH AMERICAN FLORA.*

By J. S. NEWBERRY.

AMERICA is called the New World, but, so far as we now know, that portion of North America which lies immediately north of the St. Lawrence and the Great Lakes, with its southern extension, the Adirondack region, is the oldest portion of the earth's surface. This land area, sometimes wider, sometimes narrower, and gradually increasing, has continued to exist throughout all recorded geological time; hence it is not surprising that we have here the most complete and connected history of plant life. A brief synopsis of this history I shall attempt to give you this evening.

Previous to the Cambrian and Silurian ages, and the beginning of the *legible* life record of the globe, a broad continental area occupied what is now the eastern half of North America. Whether this land bore any terrestrial vegetation we do not yet know. The Archæan rocks which compose it contain quantities of carbonaceous matter, now graphite, undoubtedly derived from plant tissue; but whether the tissue of land plants or seaweeds we have no means of knowing, in consequence of the complete metamorphism of the strata.

In the Lower Silurian age this old continent sank, and the sea flowed in over a large part of its surface. The beach formed by this invading sea we now call the Potsdam sandstone. Later deposits, which are like this, the direct wash of the land, frequently contain the impressions of land plants in abundance. In the Potsdam sandstone we have found none, and therefore we may infer that, if not absent, they were few in this age. Marine plants, however, were abundant, and the layers of the Potsdam sandstone are in a thousand places covered thickly with a network of interlacing stems of seaweeds, or rather their casts, because the vegetable tissue has all disappeared.

The limestones of this age—the organic sediments spread by the Silurian ocean over all the area it submerged—contain also abundant impressions of seaweeds, but no unequivocal traces of land vegetation. Some casts of plant stems found near Cincinnati have been described by Mr. Lesquereux as the remains of land plants, but in my judgment other proof of the existence of land vegetation in the Lower Silurian age must be furnished before we can make any positive assertion on the subject.

In the Upper Silurian age, narrower, but still extensive portions of our old continent suffered submergence, and in the deposits of this second sea we have indisputable evidence of the existence of land plants. These have been found in Michigan and Canada, and consist of the remains of ferns, lycopods, equiseta, and conifers, but the specimens are small in size and comparatively few in number, and hence we may infer that land vegetation was not abundant. We are also warranted in the inference, since we have in this earliest known land flora the highest group of cryptogams—the acrogens, and the still higher gymnosperms—that this is not the real beginning of the land flora, and that something simpler and older existed and will probably be discovered. As before, there were seaweeds in great abundance in the Upper Silurian sea.

The subsidence which gave us the series of sediments we now call the Devonian system was less extensive than those which took place before the area of permanent land was greater; and the proofs that this land was covered with a luxuriant, beautiful, and varied terrestrial flora are conclusive. We have of course made but a beginning in the disinterment of the remains of this flora, but we have already learned enough of it to sketch in clear and strong lines its principal botanical features.

Dr. Dawson has described from the Devonian rocks of Canada and New York more than a hundred species of Devonian fossil plants. These include conifers of several genera, ferns in considerable number, and not a few lycopods and equiseta. Within the United States the most interesting Devonian plants have been found in the Corniferous limestone of Ohio, and the Hamilton rocks of Gilboa, N. Y. In this age, a chain of islands ran down from Lake Erie to Tennessee, and, in the limestone which accumulated in the sea surrounding these islands quite a large number of plant remains have been found. These seem to have been floated off from the Cincinnati island and water logged in the adjacent ocean. The trunks of tree ferns representing three genera, with a number of smaller plants, have been already obtained from the insignificant excavations of the quarries at Delaware and Sandusky. At Gilboa we have the old shore upon which the plants grew, and here again we find tree ferns of several kinds, some of the trunks attaining a diameter of two feet, with *Noggerathia*, supposed to be a cycad, *Lepidodendron*, a lycopod, and that singular *Psilophyton* of Dawson, apparently connecting the lycopods and ferns, and widely diffused in the Devonian age.

The Carboniferous flora was but a continuation and expansion of the Devonian. It has been so fully revealed in our excavation of the coal beds, and has been so well studied, that all its general features have come to be familiar to every student of geology. No lengthy description of the coal flora, rich and interesting as it is, is therefore required here. I will only say in passing that the Carboniferous flora of America exhibits the same botanical characters as that of the Old World. A few genera and a large number of species are peculiar to America, but in all the great collections of fossil plants gathered from the coal strata of this country, there is perhaps no botanical element which has not also been noticed in Europe. It is impossible now to say how many species of plants have been obtained from our American Carboniferous rocks, for the literature of the subject is cumbered with much synonymy, and species have been multiplied by describing under distinct names the stems, leaves, and fruit of the same plant; but at least five hundred distinct species have been described, and that number is being added to every year. Of those already known, probably half should be considered identical with some of those found in Europe; and in some strongly marked and well-known species the identity is so complete that we cannot but wonder at the potency of the vital influence which held so closely to an elaborate pattern organic structures inhabiting different quarters of the globe.

The Triassic and Jurassic floras were essentially alike in botanical characters. They both show a complete and surprising revolution in the vegetation of the globe in the passage from the Palæozoic to the Mesozoic ages. By influences of which up to the present time we are ignorant, the great acrogenous flora of the Devonian and Carboniferous—consisting of gigantic lycopods and equiseta, the peculiar group of sigillarids, a few simple-leaved cycads, and many ferns—passed away "like a tale that is told," and, instead,

* Abstract of a lecture delivered before the Torrey Botanical Club, from the "Bulletin of the Torrey Botanical Club," July, 1880.

without known transitional forms, arose the great cycadaceous flora of the Mesozoic. Here the lycopods have shrunk to insignificance, the sigillarids are extinct, the calamites with their allies, *Annularia* and *Sphenophyllum*, are replaced by true *Equiseta*, the conifers and cycads multiplied until they constitute the most conspicuous forms of vegetation. These conifers were Araucarians; some with close rhomboidal appressed disks for leaves (*Brachyphyllum*), others with divergent fleshy scales (*Albertia*) like the Brazilian Araucaria of the present day, and still others with filiform foliage like the modern spruces (*Voltzia*). The cycads were almost infinitely varied. Some were arborescent, with lofty trunks crowned with graceful canopies of nodding plume-like fronds, while others grew in spheroidal masses marked with rhombic leaf scars, suggesting to the first discoverer gigantic birds' nests (*Mantellia nidiformis*). Remarkable changes are also noticeable in the ferns. Those with highly compound fronds (*Sphenopteris, Pecopteris*, etc.), which existed in such vast numbers in the Carboniferous age, were to a great degree superseded by those with simple linear or spatulate fronds (*Taeniopteris*), and by those in which the stipe bore a horizontally-expanded pedate or spiral frond (*Camptopteris*, etc.) or broad pinnate or radiate fronds, like *Clathropteris*, of which the surface was divided into rectangular areoles by the strong nervation. All these forms were as unlike as possible to the ferns of the Palæozoic ages, and had little resemblance to any that are now living.

Abundant remains of the Triassic flora are found in the rocks of this age at Richmond, North Carolina, in New Jersey, and in the Connecticut Valley. In certain localities vegetation was so luxuriant that it accumulated in the form of extensive and thick beds of peat, which are now coal. Associated with these coal beds near Richmond, and in the Deep and Dan River basins of North Carolina, we have a full representation of the plants from which the carbonaceous matter was derived, and no stronger proof of the wide difference between the floras of the Carboniferous and Triassic ages could be afforded than by the comparison of the plants preserved in the roof shales of the coal beds of Virginia and Pennsylvania; the first being Triassic, the second Carboniferous.

A large number of Triassic plants have also been found at the old copper mines near Abiquin, New Mexico, and at Los Bronces, Sonora, all representing the same botanical groups, cycads in large variety (*Otozamites, Podozamites*, etc.), a preponderance of monophyllous ferns, with a few of the finer cut species.

Of the *Jurassic flora* of North America very little is known. The Triassic plants are for the most part from the upper members of the series, or Rhætic beds of the Old World; and it is quite possible that the colored marls and clays which are found about Baltimore, forming the summit of the Trias, should be regarded as Jurassic. They have yielded quite a number of plants, principally cycads and finely divided ferns, all of new species.

Cretaceous Flora.—Nowhere in the world up to the present time has there been found an angiospermous leaf in the Triassic or Jurassic rocks. In India, China, Europe, America, the flora of the Jura and Trias has the character I have already ascribed to it; but resting immediately upon these beds so full of cycads, conifers, and ferns, we find in New Jersey, and in innumerable localities in the far West, the Lower Cretaceous sandstones and clays, full of the remains of plants, and these altogether unlike those which had gone before.

From causes which we cannot as yet understand, nor even conjecture, the vegetation of the world was at this period of its history more completely revolutionized than at any previous epoch; for here came in the angiosperms, by no transition indicated in the record, but by a sudden irruption. At the beginning of the Cretaceous age they seem to have spread over the earth's surface, and soon became the predominant and characteristic forms of vegetation, giving to Nature the aspect which she now exhibits.

In the Lower Cretaceous clays of New Jersey, and their equivalents, the Dakota group of the far West, the representatives of the Middle Cretaceous strata of the Old World, the remains of at least one hundred distinct species of angiospermous arborescent plants have already been found. With them are many conifers of Araucarian affinities, and fan palms like those of the present day; but the forests that covered the continent when the Cretaceous sea invaded it consisted mostly of oaks, willows, sassafrases, magnolias, tulip trees, sweet gums—the genera most abundant in our living forests. Here, then, we have, according to the present state of our knowledge, the beginning of our modern flora. As to where it originated, and by what influence it was developed, we as yet have no information; but inasmuch as a long period of time is probably represented by the line which divides our Triassic or Jurassic and Cretaceous rocks, an interval in which the lowest members of the Cretaceous series were accumulating in the Old World, it is evident that we must go elsewhere to find the record of the gradual substitution of the angiospermous flora of the Chalk for the cycadaceous vegetation of the Trias and Jura.

In the studies that have been made of the foreign Cretaceous flora it is said that the change was gradual; first, a few angiosperms mingled with the predominating cycads and ferns; and subsequently, the angiosperms becoming more numerous. But it is also stated that no transitorial forms mark the passage from one flora to the other.

Descriptions of some of the Cretaceous plants of the far West were published in 1869 by myself, in a paper on our later extinct floras, which appeared in the "Annals of the N. Y. Lyceum of Natural History." More recently a much larger number have been described by Mr. Lesquereux in one of the series of Dr. Hayden's Reports, devoted entirely to the Cretaceous flora.

Within the past year we have begun to open an herbarium of fossil plants in the Cretaceous beds of New Jersey, which promises to give us a more accurate knowledge of this flora than has been obtained from any other source. A large number of angiosperms and conifers have already been obtained from these beds, and Mr. Britton of this Society, will spend the coming summer in making further collections from the clays and sands along the Raritan River, so that when we meet again in the autumn I shall hope to be able to report some interesting results of this investigation.

Of the herbaceous and humbler elements of the Cretaceous flora we have as yet little knowledge, but the Cretaceous forest stands before us in well-defined characters. We rather pride ourselves now on the variety, beauty, and majesty of our forest trees, but we have reason to believe that the forests of the Cretaceous included at least as large a number of species, and perhaps as imposing and beautiful individuals as those of the present day.

Since the Cretaceous flora consists of so many of the genera now growing in our climate, we must conclude that the climate which prevailed during the Cretaceous, within the area of our possessions, was also temperate, and that the theory somewhat widely promulgated that our flora began in the Arctic regions and spread south with the gradual decrease in temperature is without foundation in facts.

Tertiary Flora.—The flora of North America during the Tertiary ages seems to have been but a continuation of that of the Cretaceous. Many new genera and species were added, and a number of the latter are still in existence, but the botanical aspect of the flora was similar to that prevailing both before and after. During the Tertiary a mild climate extended over the entire North American continent, and as we know by the abundant remains of plants discovered in Alaska, on Mackenzie's River, Disco Island, and Greenland, a luxuriant flora similar in character to that of our Middle and Southern States was spread all along the northern seaboard. The remains of the living deciduous cypress, *Taxodium distychum*, have been found in nearly all the Tertiary deposits explored, even as far north as Greenland. The northern range of this species is now about the 36° of latitude, from which we may infer that the average annual temperature of the entire continent in the Tertiary age was above 50° Fahr. During this period there was a land connection between North America and Europe by way of Iceland and the Hebrides, and also with the Asiatic continent by way of Behring Strait. Taking advantage of this opportunity our American flora seems to have marched over and occupied both these continents. In Southern Europe the climate at the beginning of the Tertiary was sub-tropical, and the Indian Ocean communicated with the Atlantic through the Mediterranean. The gradual elevation of the Alps, Pyrenees, etc., during the Tertiary age, resulted in the formation of a barrier which limited the reach of austral influences and gave a temperate climate to the interior of Europe. At this time the American temperate flora descended from the north and occupied all Europe; for we find in the Miocene or Middle Tertiary strata the remains of the deciduous cypress, our magnolias, the tulip tree, sweet gum, sassafras, and the American poplars. When the ice period came on, however, these plants were driven southward, but found their retreat cut off by the Mediterranean, and were thus mostly exterminated. Subsequently, when a milder climate supervened, the vacant area thus formed was entered and possessed by a flora for the most part of Asiatic origin. In Japan and China, however, our American flora still exists. There is a remarkable similarity between the flora of Japan and that of Eastern America, many of the species being identical, and others so closely allied that they must have had a common origin. We find, too, in China and Japan some interesting members of our American Tertiary flora, which, once common here, have been by some cause exterminated, while they still exist in Asia. Of these, perhaps the most striking examples are the *Salisburia*, or ginko, a genus well represented in our Cretaceous and Tertiary flora, and the *Glyptostrobus*, another conifer which was abundant both in Europe and America in the Tertiary age, but, disappearing elsewhere, has survived in China.

I have said that our Tertiary flora was directly derived from the Cretaceous, and was the distinct progenitor of that of the present day. This is strictly true; but, if we may judge by the arborescent plants, our living flora is but a wreck and relic of that which covered our continent before the ice period. We have already collected from the Tertiary strata in various parts of the country the remains of more species of forest trees than are now growing on its surface, and yet every year sees important additions made to the list. Imperfect as is the picture which these fragmentary fossils give us of the Tertiary flora, we find in it an explanation of some facts in the flora of the present day which have long puzzled botanists. For example, our giant trees, the two Sequoias of California, though of enormous size, are confined to very narrow geographical limits, the mammoth tree being restricted to a few groves; so in our eastern forests the sassafras, the sweet gum, and the tulip tree are each a solitary representative of its genus, and it has been a matter of surprise that these noble and striking trees should have no living relatives; but as we turn the pages of the Tertiary herbarium we find each of these genera represented by many species, and the species now living and restricted to narrow bounds, then having a very extended range, and existing in countless numbers. We find, too, that we have lost many of the grandest elements in the Tertiary flora; for example, our sycamores (*Platanus occidentalis*, and *P. racemosus*), were in Tertiary times represented by a half dozen species which are now extinct, and of these, two at least would seem to have surpassed in magnitude and beauty our common one, great and grand as it is; for I have leaves of two extinct sycamores that are each one and a half feet in diameter. Camphor trees, palms, and figs were also features in our Tertiary flora which exist no longer outside of the tropics.

The most potent influence which operated to change the flora of the Tertiary to that of the present day was undoubtedly the cold of the ice period. Although less destructive here than in Europe, because the southern extension of our continent offered a place of retreat before the advancing ice sheet, the substitution of an Arctic climate for the mild temperature which prevailed in Tertiary times throughout the northern portion of the continent, and the spread of unbroken fields of snow and ice over all the surface north of the fortieth parallel, caused the destruction of all plant life over three-fourths of the area covered with the luxuriant growth of the Tertiary vegetation. It also forced the remnant into such narrow quarters that vast numbers of species were exterminated, and left the flora in the fragmentary condition it now exhibits. The effect upon the fauna was still more disastrous, for a forest tree needs no greater space than is occupied by its roots in the earth and its branches in the air, while the surface required for the support of one of the larger mammals is much greater. Hence of the grand Tertiary fauna scarce a remnant survived, while of the plants, when better days returned, and the snow fields and ice sheets retreated to Greenland, a sufficient number came back from their banishment to cover the central portion of the continent with a flora which retained all the essential botanical characters of that of the Tertiary, but the vicissitudes through which it had passed had told sadly upon it. Many of its grandest and most beautiful elements had disappeared for ever, while a few of its magnolias, tulip trees, sequoias, and liquidambars survive as solitary representatives of the groups to which they once belonged, and form groves instead of boundless forests. Overtopping in their grandeur, or outshining in their beauty, their present associates, they attest the general magnificence of those ancient forests that were composed of their progenitors and extinct relatives, their equal or superiors.

RESULT OF DRYING SEEDS.

By E. WOLLNY.

MANY experiments have shown that the seeds of several plants, including flax, cucumbers, pumpkins, and melons, yield very plentifully when they have been dried at a temperature of 30° to 50° C., notably flaxseed, growers of which always seek old seed, as yielding a better and longer flax; the author presumes this is because of the natural drying of the moisture originally contained in the seeds. This fact led the author to undertake a series of experiments with the seeds of many food plants in order to learn the effect of artificial drying on their productiveness.

In view of the danger of too high a temperature killing some of the seeds, they were not heated above 32–35° C., so that a long time was necessary to dry them; the undried seeds were meanwhile kept in airtight bottles, and lost scarcely any moisture. The experiments were arranged in two series: first, to ascertain the effect upon the *growth* of the plant; and, secondly, the effect upon the productiveness. The answer to the first question is, that the drying of the seeds delays the growth of the plant, and that the plants produced from the dried are much more irregular in size than those from undried seeds, and that notwithstanding the greatest care in drying, the seeds so treated have a less percentage of germinating power. The effect on the crop, however, is very different, the figures showing clearly that the effective produce of the dried seeds is greater than from the undried.—*Bied. Centr.*

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